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A.M.A. ARCHIVES OF
OTOLARYNGOLOGY

Acute Frontal Sinusitis

Robert C. Kratz and William C. Thornell

Treatment of Membranes and Synechiae of the Anterior Part of the Glottis

Justo M. Alonso and Justo Elias Alonso Regules

Otosclerosis

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Hypersensitization to Penicillin and Streptomycin Sulfate During Proetz Displacement

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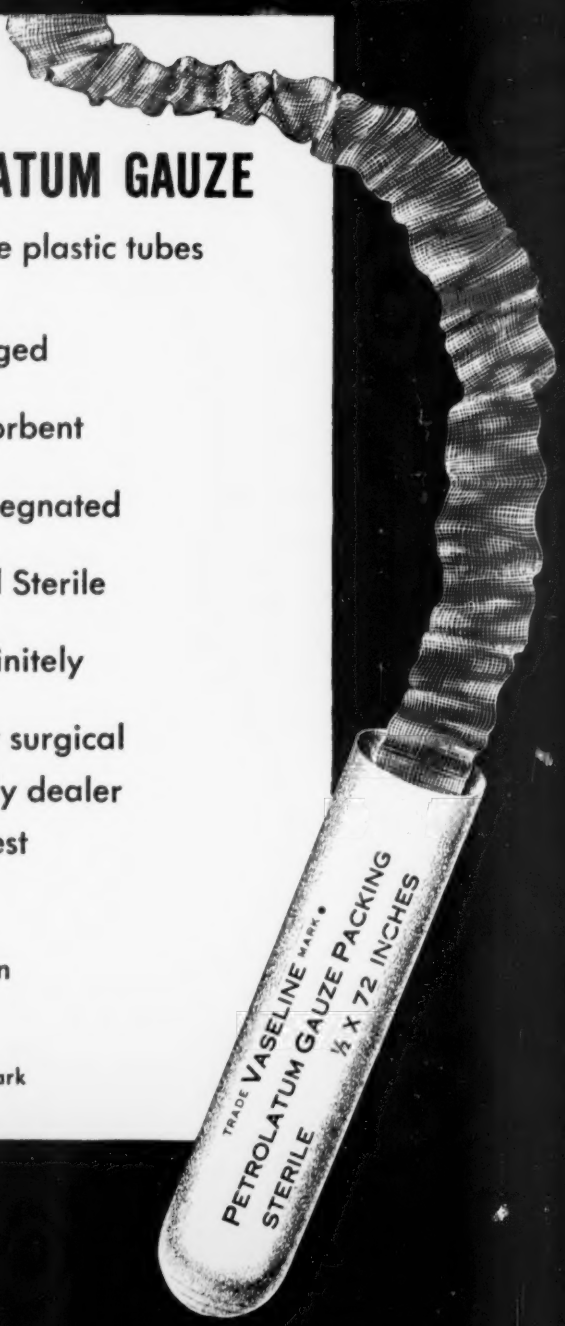

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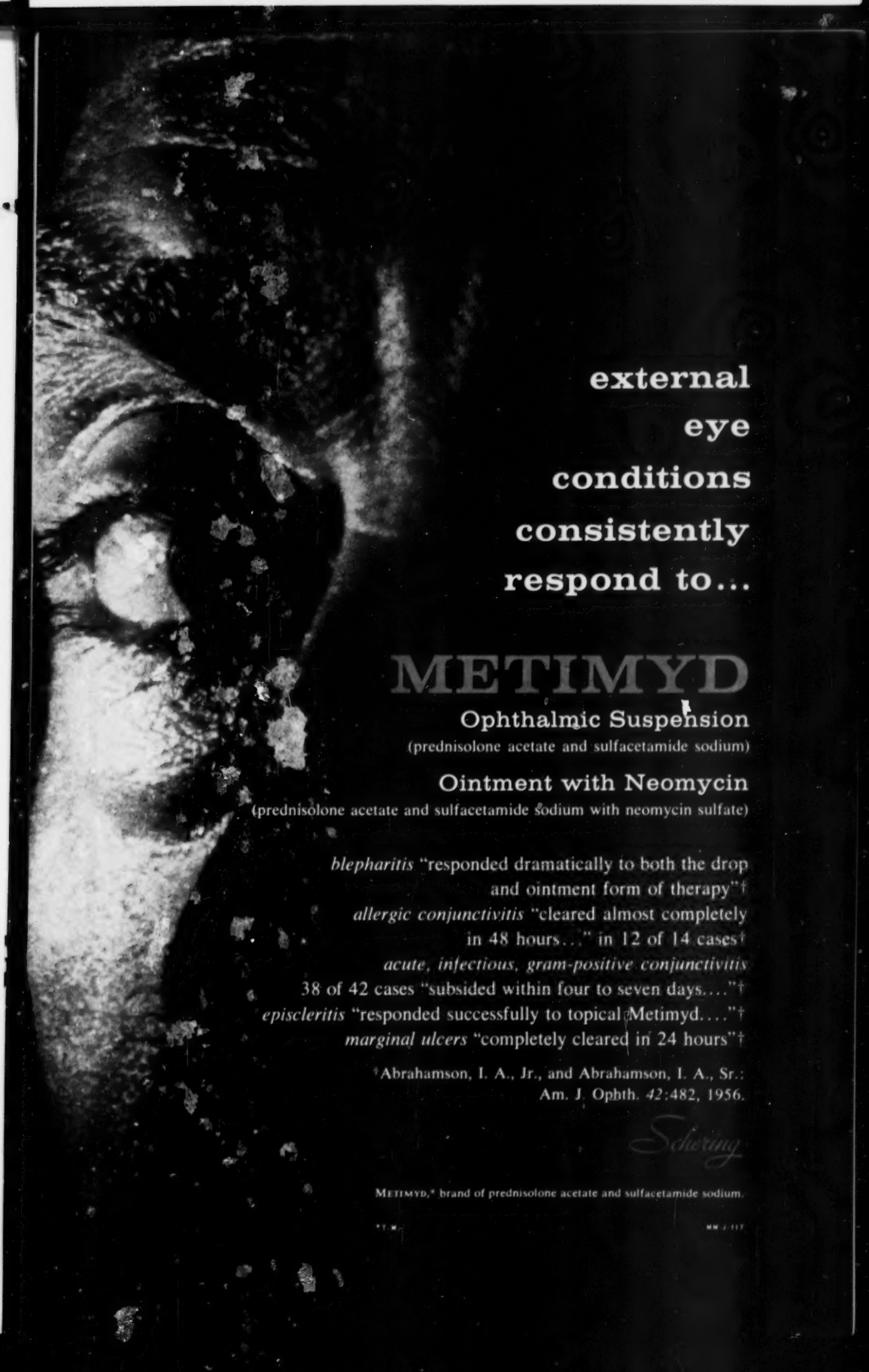

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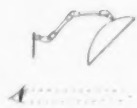

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Acute Frontal Sinusitis

Complications and Treatment

ROBERT C. KRATZ, M.D., Newport, Ky., and WILLIAM C. THORNELL, M.D., Cincinnati

Acute frontal sinusitis is a medical and occasionally a surgical emergency. It is not a common involvement. It is not a disease to be treated with inadequate antibiotic therapy, sulfonamides, sedation, and the advice "come back tomorrow if you are not feeling better."

The patient develops a cold associated with fever, malaise, and head pain located over the involved sinus. It is this latter symptom which induces him to consult his family physician for advice and treatment. It is characteristic of acute frontal sinus pain to show definite periods of occurrence each day. The pain usually begins in the morning one or two hours after rising and increases in severity toward noon, and diminishes in the middle of the afternoon. Early in the disease the acute infection produces edema with thickening of the mucous membrane due to the extravasation of serum into the submucosal area. This mucous membrane may become engorged to many times its normal thickness. If the patient is unable to overcome this early stage of involvement, the inflammation then passes to the suppurative stage, at which time petechial hemorrhages in the mucous membrane and varying degrees of necrosis of the mucosa may occur. The infection may remain a relatively benign one or, on the other hand, become a rapid progressive fulminating type of infection. It is in the early stage that an inadequate antibiotic regimen consisting of one or two injections of penicillin and the use of various vasoconstrictors may produce a variable period of improvement, to be followed later by the more serious complications of a progressive suppurative involvement of the frontal sinus. These complications may be a progressive osteomyelitis of the cranial bones, epidural abscess, subdural abscess, meningitis, brain abscess, sagittal sinus thrombosis, orbital cellulitis, or orbital abscess. Failure to treat this disease intensively and adequately with proper respect may result in long periods of hospitalization, surgery, and, later, plastic procedures.

The symptoms of sinusitis may be classified as general and local symptoms. Fever and associated malaise are a frequent finding. Pain is present over the affected sinus and may radiate to the temporal area. In acute frontal sinusitis, examination reveals tenderness to be present on pressure over the floor of the frontal sinus and frequently percussion elicits pain over the anterior wall of the sinus infected. In the early stages of acute frontal sinusitis, the discharge is serous in nature, later becoming purulent. It is located anteriorly in the middle meatus. Should the nasofrontal duct become obstructed, the pain will become severer. Mild edema occurring over the frontal bone may indicate a periostitis, which then may progress to osteomyelitis, if inadequately treated. Since there is a lag of 10 or 12

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From the Department of Otolaryngology, University of Cincinnati, College of Medicine.

days from the time the disease invades the frontal bone and its detection on roentgenograms, these are not usually of much help in determining an early osteomyelitis, and intensive treatment should be started before these findings are evident. With mild necrosis of the mucous membrane lining the frontal sinus and nasofrontal duct, there may be associated thrombosis of the vessels and extension to the intracranial contents through the venous channels, through the lymphatic channels, or by direct extension of the infectious process. H. L. Williams [1] has emphasized that since direct communication exists between the veins of the upper part of the mucosa lining the frontal sinus and those in the diploe of the frontal bone, these veins may become involved in a periphlebitis, and in this manner the disease extends from the sinus into the frontal bone, producing osteomyelitis of the skull. Osteomyelitis is characterized by high fever, severe pain, and the development of swelling over the forehead. This becomes doughy and later red in color. The infection may extend into the orbital cavity, producing a retro-orbital cellulitis and then, still later, a retro-orbital abscess. Direct intracranial extension of infection may lead to an epidural abscess and/or a subdural abscess. Retrograde thrombophlebitis extending intracranially in toward the brain may result in brain abscess. Meningitis is not an infrequent intracranial complication. The organisms which produce this involvement may be a hemolytic type of Staphylococcus aureus or an anaerobic microaerophilic short-chain Streptococcus.

Treatment

Much has been written regarding the treatment of acute frontal sinusitis. We should like to emphasize that the patient should be impressed with the seriousness of this involvement. Hospitalization is not a necessity, but it may be preferable. The rapidity of extension of acute frontal sinusitis depends upon the type and virulence of the infecting organism as well as the patient's ability to resist and combat such an infection. For the benign type of frontal sinusitis the patient can be handled as an ambulatory case. Three factors are important regarding treatment: first, the relief of pain; second, the institution of drainage, and third, destruction of the infecting organism. Various sedatives in addition to x-ray therapy are helpful in relieving the pain of an acute frontal sinusitis. Vasoconstricting solutions should be limited because of the secondary vasodilatation and edema that result following their use. The use of Dowling packs daily, consisting of pledgets of cotton with 25% mild silver protein (Argyrol), placed in the middle meatus for shrinkage over a period of one-half hour, followed by gentle suction, is preferable to vasoconstrictors, in so far as shrinkage is obtained by osmosis rather than by vasoconstriction. Adequate rest and moist warm compresses applied over the involved sinus are effective in relieving pain and aiding in the recovery from this type of involvement. Antibiotics, when prescribed, should be continued five to seven days after complete remission of symptoms. Although wide-spectrum antibiotics should be selected, cultures and sensitivity tests are of value in determining the most effective antibiotic to be used.

When the frontonasal duct is completely obstructed and the patient is suspected of developing a fulminating type of sinusitis, such as is related to follow swimming, persistent pain may continue in spite of nasal shrinkage and intensive antibiotic therapy. With a progression of symptoms accompanied by edema developing over the frontal bone and involving the upper eyelid, a trephine opening into the floor of the frontal sinus for drainage is indicated. The procedure is quite simple and requires only a short period of time under local anesthesia. It is made into the frontal sinus through the bone that does not contain diploe tissue, that is, through the floor of the frontal sinus. It gives immediate relief and helps prevent further extension of the process. This can be readily carried out using the method described by Goodyear [2] with a nail

trephine drill or by using a gouge and mallet. Through this opening, irrigation of the sinus is readily carried out should the surgeon desire. There is no noticeable resultant scar.

Report of Cases

CASE 1.—A 13-year-old Negro boy was admitted to Cincinnati General Hospital on Aug. 20, 1954. At this time the temperature was 104 F (oral), and this was accompanied by edema over the right eye. There was a history of an acute head cold two weeks previous to admission. Six days prior to admission, his family physician had given him one injection of penicillin. Following the injection of penicillin, improvement was noted until the day of admission, when swelling appeared over the frontal area accompanied by headache and visual hallucinations.

Physical examination revealed a cooperative, well-developed boy, aged 13, with normal blood pressure, pulse, and respirations and a temperature of 104 F (oral). There was a moderate amount of edema over the right supraorbital and temporal areas. There was noted an inability to wrinkle the forehead and to elevate the right upper eyelid. It was felt that this paralysis was due to a local inflammatory process, secondary to osteomyelitis of the frontal bone. There was no evidence of discharge in the nasal passage. X-rays of the paranasal sinuses revealed clouding of the right frontal sinus. There was some haziness extending into the adjacent frontal bone. There was a radiolucent area 1 cm. in diameter to the right of the midline above the upper limit of the frontal sinus. Aqueous penicillin, 1,000,000 units every three hours, and sulfisoxazole (Gantrisin), 1 gm. every six hours, were administered. On the fourth day, improvement was noted and penicillin was decreased to 600,000 units, twice a day. In view of the x-ray findings and the persistence of visual hallucinations, an epidural abscess was suspected complicating an osteomyelitis involving the frontal bone. On the 13th day following hospitalization, the patient was taken to surgery, at which time a coronal incision was made at the hairline extending from one ear to the opposite ear (Fig. 1). The periosteum was elevated anteriorly, and the scalp flap brought down over the face. The entire frontal bone was uncovered. The anterior wall of the frontal bone covering the right frontal sinus was found to be soft and necrotic. This was removed down to the supraorbital ridge. The bone in this area appeared normal. The posterior wall of the frontal sinus was noted to be quite white and avascular. This was removed, exposing an epidural abscess lying over the sagittal sinus and extending over the anterior lobe of the right cerebral hemisphere. A culture was taken of the purulent material lying within the epidural abscess and was later

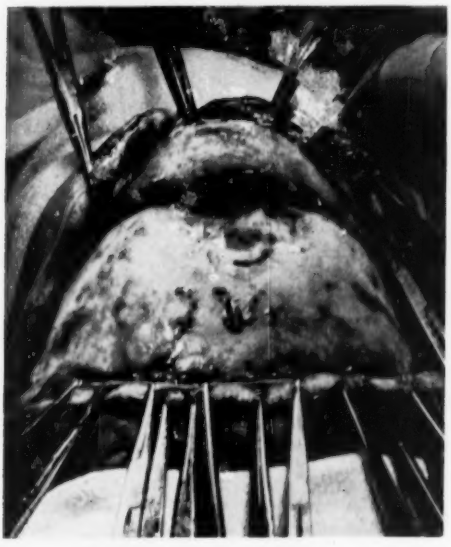


Fig. 1.—The coronal incision is recommended when good exposure of the frontal bone is necessary. Bleeding is usually quite profuse, but is most readily controlled with Adson's scalp clips (or Raney's scalp clips).

Fig. 2.—The area of involved dura and portion of the sagittal sinus is exposed after the anterior wall and portion of the posterior wall of the right frontal sinus has been removed. Note the involvement of the periosteum on the flap which has been turned down over the face.

Fig. 3.—The coronal incision has again been made, and the dura and sagittal sinus are exposed. A small amount of bone degeneration has taken place.

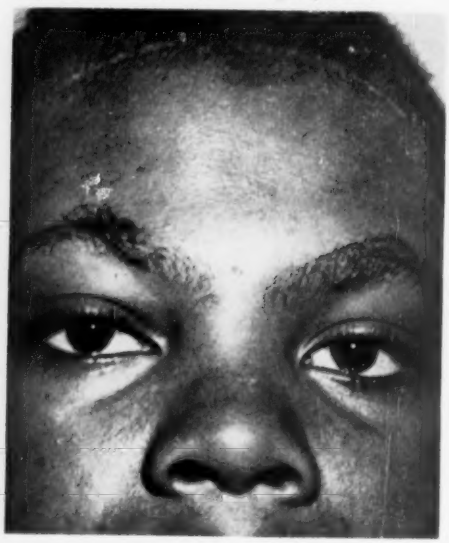
reported negative for bacteria. The entire area of involved dura was exposed until normal dura was identified. The area of dura and sagittal sinus exposed was 3 by 2.5 cm. (Fig. 2). Following this, an opening was made into the nose through the anterior ethmoid cells and nasofrontal duct, into the right nasal passage, and the intersinus septum between the right and left frontal sinuses was removed. The left nasofrontal duct was left untouched. The scalp flap, including the periosteum, was returned to its original position, and following suturing of the incision a firm external pressure dressing was applied. The patient made an uneventful recovery and was discharged from the hospital on Sept. 17, 1954. A padded external metal disc was applied over the area to protect the frontal region where the bone had been removed over the right cerebral hemisphere.

Nine months later the patient was readmitted for surgical treatment of the depressed area in the right frontal bone. At this time an incision was made at the point of the original incision in a coronal fashion from one ear to the opposite ear. This was carried down to the skull and the periosteum carefully dissected anteriorly from the dura and frontal bone (Fig. 3). A piece of iliac crest removed from the right ilium was fashioned with a dental burr to perfectly fit the right frontal defect, and the flap was returned (Fig. 4). No fixation of the bone was necessary. The incision was closed, and an external pressure dressing was applied. The patient made an uneventful recovery, and the pulsating area of exposed dura is no longer present (Fig. 5).

In retrospect, it would seem that the recovery period for this patient could have been shortened had we operated the fourth hospital day. Had this localized epidural abscess ruptured, the disease would have be-

Fig. 4.—The outer cortex of the ilium has been fashioned to fit the defect and cover the exposed dura and sagittal sinus.

Fig. 5.—Photograph taken two months after surgery reveals an absence of the former depression of the frontal area, and the pulsating area in the frontal region is no longer present.



come a meningitis or brain abscess. The incision employed in this case demonstrates the excellent exposure of the frontal bone which can be obtained by using a coronal incision. The placement of this incision within the hairline minimizes the postoperative scarring. We recommend this incision in cases where there is suspected involvement of bone. We should also like to emphasize the simplicity of repair of this type of frontal bone defect with a bone graft through this type of incision.

CASE 2.—The patient, a 16-year-old boy, presented a history of headache and fever which began Dec. 18, 1954, at which time an injection of penicillin was given by his family physician. On Dec. 27, 1954, he was again given two more injections of penicillin by his physician. He was seen in the receiving ward at Cincinnati General Hospital on Dec. 30, 1954, with complaints of headache, numbness in the left hand, nausea, vomiting, chills and fever (102 F, oral), and stiffness of the neck. Examination at this time revealed a well-oriented, cooperative, acutely ill patient with slight tenderness over the frontal area. There was loss of finer movements of the fingers of the left hand, as well as weakness of the left hand. The Babinski test was equivocal on the left and normal on the right. Lumbar puncture carried out at this time revealed an initial pressure of 470 mm. of water. Following the removal of 10 cc. of cloudy fluid, the pressure was 230 mm. of water. Spinal fluid cell count revealed 1800 white blood cells per cubic millimeter, of which 70% were neutrophils and 30% were lymphocytes. Clinical examination at this time revealed some crusting in the nose and edema of the inferior turbinate on the right side. There was no evidence of mucopurulent discharge. X-rays of the paranasal sinuses revealed clouding of the right frontal sinus and right ethmoid cells. On Dec. 31, 1954, 30 cc. of creamy pus was evacuated from beneath the dura through burr holes made 2 cm. from the coronal suture and 2 cm. above the right frontal sinus. A second burr hole was made in the right temporal area. The pus apparently overlay the entire right side of the brain from the falx to its base. Following the above neurosurgical procedure, a 5 mm. trephine opening was made into the floor of the frontal sinus on the right side. A small amount of pus was evacuated. On Jan. 17, 1955, another loculated pocket of sterile pus was drained by the neurosurgeon from the subdural space in the occipital area on the right side. Following this, the patient gradually made a more or less uneventful recovery.

CASE 3.—The patient, a 17-year-old Negro boy, was seen in the receiving ward at Cincinnati General Hospital on July 6, 1955, because of severe convulsions. He had been in good general health until two or three days before hospital admission except for complaints of frontal headache and pain which had persisted over two to three months. He noted increasing frontal pain a few days before admission and developed fever and malaise. On the day of admission he was noted to have generalized convulsive seizures, and had perhaps six such episodes before being admitted to the hospital. On admission, he was semicomatose. The pupils reacted to light, but the left pupil was slightly larger than the right. The optic discs appeared normal. There was slight rigidity of the neck, and he was noted to have less voluntary movements of the right extremities as compared with the left. Muscle tone on the right was increased. At the time of admission, attention was directed mainly to the central nervous system findings and little attention was paid to the ear, nose, and throat findings until x-rays of the paranasal sinuses showed the presence of a frontal sinusitis. Examination at this time then revealed a small amount of mucopurulent material in the left nasal passage. X-rays of the paranasal sinuses showed clouding of the frontal and ethmoid sinuses. Cerebral spinal pressure was 290 mm. of water, with 70 polymorphonuclear leukocytes. The protein was 74 mg/100 cc. and sugar 40 mg/100 cc. The patient was placed on sulfadiazine, tetracycline (Achromycin), and aqueous penicillin. The day following hospitalization, no improvement had been noted. At this time under local anesthesia, the neurosurgeon made bilateral temporal, left frontal, and posterior parietal burr holes and attempted drainage, but no pus was encountered. Following this, the otolaryngologist made a small trephine opening into the floor of the left frontal sinus after the method of Goodyear and 25 cc. of sanguinopurulent material was removed. Cultures of this material revealed S. aureus. Twenty-four hours following drainage of the above the patient showed rapid improvement, and appeared apparently normal five days following surgery. The final diagnosis was acute suppurative frontal sinusitis on the left side with acute encephalitis (cerebritis).

CASE 4.—The patient, a 60-year-old widow, was admitted Jan. 29, 1952, at the Cincinnati General Hospital. The patient had been found on the floor of her apartment by her janitor and was brought in to the hospital by the police. It was suspected on admission to the receiving ward that she was suffering from an overdose of barbiturates. The history was obtained that 10 days prior to admission she had developed a swelling of the left

upper eyelid accompanied by severe pain. The pain persisted, but the swelling subsided. She had noted an occasional emesis. Six days prior to admission she had been examined by her family doctor, who had noted a temperature of 99 F and her complaints of severe frontal headache. She was given meperidine (Demerol) and 300,000 units of procaine penicillin G. She refused further treatment and locked herself in her room, where she was subsequently found comatose. At the time of admission to the hospital, her temperature was 103 F, pulse rate 80, respirations 32 and of a Cheyne-Stokes character. Her blood pressure was 174/80. She was comatose and reacted only to painful stimulation. There was no evidence of trauma. Examination of the nose revealed a mucopurulent discharge in each nasal passage. There was some mild edema of the orbit beneath the supraorbital ridge. The pupils were round, regular, and equal. The light reflex was normal. Extraocular movements were normal except for slight weakness of the left abducens muscle. Subsequent observations revealed a variability in the size of the pupils, the left being slightly larger than the right. Ophthalmoscopic examination revealed engorgement of the retinal veins and blurring of the optic discs. The oral hygiene was extremely poor, and purulent exudate was noted on the postpharyngeal wall. There was moderate nuchal rigidity. The superficial jugular vein on the left was larger than that on the right. Abdominal reflexes were absent. The deep reflexes were depressed. All extremities moved when stimulated with a painful stimulus, but spontaneous movement seemed less on the right side. Cerebrospinal fluid studies were carried out and revealed an initial pressure of 460 mm. of cerebrospinal fluid with 740 white blood cells, with 66 mature lymphocytes and 34% polymorphonuclear leukocytes. The Pandy reaction was 4+. No bacteria were noted on the smear. The white blood cell count was 36,900, and hemoglobin content was 13 gm/100 cc. Urinalysis revealed a 2+ albumin. It was the consensus of opinion that she had a meningitis, subdural empyema, and possibly a brain abscess in the left cerebral hemisphere. X-rays of the paranasal sinuses revealed clouding of both frontal sinuses with evidence of bone destruction involving the posterior walls. Under local anesthesia, occipital burr holes were made and the ventricles catheterized. The fluid removed from the ventricles was xanthochromic and clear. Another burr hole was placed posterior to the left frontal sinus, and through this a large amount of subdural purulent exudate was removed. An incision was made over the left frontal sinus, and the sinus was entered. A large amount of creamy yellow purulent exudate was encountered. The left anterior and posterior bony wall of the sinus was removed along with a majority of the roof of the left orbit. Incision through the dura revealed a large amount of pus overlying the brain and an associated abscess extending into the brain substance itself. This was evacuated and polyethylene catheters inserted for irrigation with penicillin. A direct smear of this material removed revealed Gram-positive cocci, but later cultures proved negative. The patient never regained consciousness following surgery. Her temperature ranged between 102 and 104 F. Massive doses of penicillin, streptomycin sulfate, and oxytetracycline (Terramycin) were prescribed. The subarachnoid pressure rose to 300 mm. of water, and a catheter was placed in the lumbar subarachnoid space. In spite of intensive antibiotic and supportive therapy, she died on the sixth postoperative day.

Summary

A plea is entered here that physicians take a more serious attitude regarding acute frontal sinusitis and its treatment.

Four complicated cases of acute frontal sinusitis are presented.

When a patient with an acute frontal sinusitis develops a bizarre behavior pattern, hallucinations, convulsions, or other neurological findings, one should expect or suspect a central nervous system complication.

A trephine opening into the floor of the frontal sinus should be made early in the fulminating cases with the use of a gouge and mallet or a nail trephine, such as is described by Goodyear.

The coronal incision is suggested when there is need for wide adequate exposure of the frontal bone with the anticipation of a good cosmetic appearance as a final result.

2508 Auburn Ave. (19) (Dr. Thornell).

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2. Goodyear, H. M.: Surgery of the Frontal Sinus, Laryngoscope 57:340-353 (May) 1947.

Treatment of Membranes and Synechiae of the Anterior Part of the Glottis

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Cicatricial and congenital membranes of the larynx are generally found in the anterior portion of the glottic chink, joining the part of the vocal cords nearer to their anterior insertion. They are very rarely an obstacle to breathing, but they disturb phonation in variable degree.

Congenital membranes, known as palmate membranes because of their likeness to the interdigital membranes of web-footed animals, are of membranous consistency, not very thick, and easy to section.

Cicatricial membranes, caused by accidental or operative trauma (laryngofissure), are hard, fibrous, and thick.

Cicatricial membranes are principally seen in adults, especially those which are the result of an operation, such as the extirpation of an epithelioma of a vocal cord by laryngofissure or of an epithelioma of the anterior commissure by Tapia's frontal operation or a modification of it.

It is very simple to cut a laryngeal membrane by means of the endoscopic method, especially if it is congenital, but these membranes have such a tendency to grow together again that all intervention consisting of simple section becomes illusory and useless.

Many techniques have been proposed to avoid that difficulty. The following are the three principal types.

1. The membrane is sectioned along the edge of a vocal cord (not across the middle). It remains fixed to the edge of the other cord and hangs or moves with breathing movements, but the two bloody surfaces do not touch each other. One month later, when the sectioned surfaces have cicatrized, the membrane is extirpated, sectioning being carried out even to the vocal cord to which it has been fixed. This procedure gives satisfactory results in a certain number of congenital membranes but not in the case of cicatricial ones.

2. The membrane is sectioned the endoscopic way. A curved needle is passed below the thyroid or the cricoid cartilage; it is driven along the tracheal and laryngeal slits, and its point comes out at the superior thyroid notch. With the help of that needle, a metallic thread, as thick as possible, is passed all the way through. The ends of the metallic thread are fixed at the exterior portion, each to a bone button. The thread remains interposed between the two bloody surfaces of the anterior part of the vocal cords. This procedure, due to Hasslinger (Vienna), gives very good results, but it has been practically abandoned.

3. The method mostly used nowadays, especially in North America, is as follows. A median laryngofissure is made. The membrane is sectioned or extirpated. A plastic plate is interposed between the sectioned surface of the thyroid cartilage and the anterior part of the vocal cords. It is provided with a wooden portion, fixed on its external edge, giving the whole the shape of an L or a T. The external part is to prevent the plate, which is in the anterior portion of the

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endolarynx, from moving or falling. It is also useful because it allows the plate to be taken out for cleaning and to be placed in position again.

The inconvenience of this procedure is the need of a laryngofissure and the dislocation or separation of the anterior part of the vocal cords, but during all the time prosthesis is conserved. It is a reliable procedure, but it always charges the voice and obliges the patient to be kept under careful watch.

The method which we have used has something of each of the last two techniques. It consists of sectioning the membrane by means of the endoscopic method and putting a plastic plate, placed like Hasslinger's metallic thread, between the bloody surfaces, without making a laryngofissure.

In children it is convenient to use general anesthesia. In adults we use local anesthesia, with or without previous preparation with barbiturates or atropine-morphine, according to the patient.

The position is the usual one for tracheoscopy.

We use as principal instrument a thin plate of plastic material such as polyethylene, with a straight side and a curved one (segment of a circle). The straight side is 1 cm. long, and the measurement of the arc is 0.75 cm. This size is used for adults. For children the size depends on the diameter of the trachea. A silk or nylon thread is passed through the plate along the straight side, 1 or 1.5 mm. from the edge, leaving 20 or 25 cm. of thread free at each end.

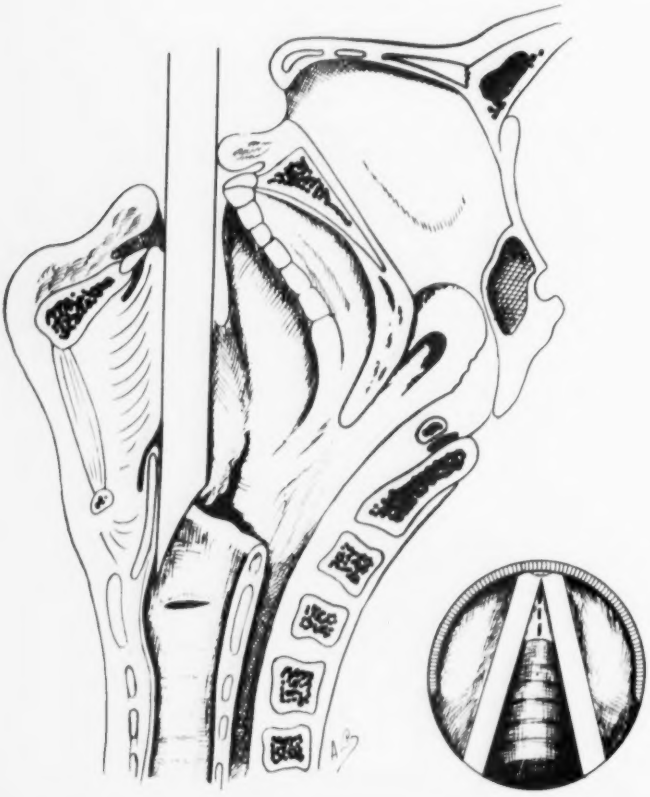

Figure 1

The thread must not slide from the plastic plate; it must be firmly fastened to it. Once the plate is in position in the larynx, if one end of the thread (superior or inferior) should break, the plate will stay fixed to the other end and thus will not fall into the patient's trachea.

It is also convenient to paint the plastic plate black or green so that it may be easily differentiated from laryngeal formations and tracheal mucous membrane.

Figure 2

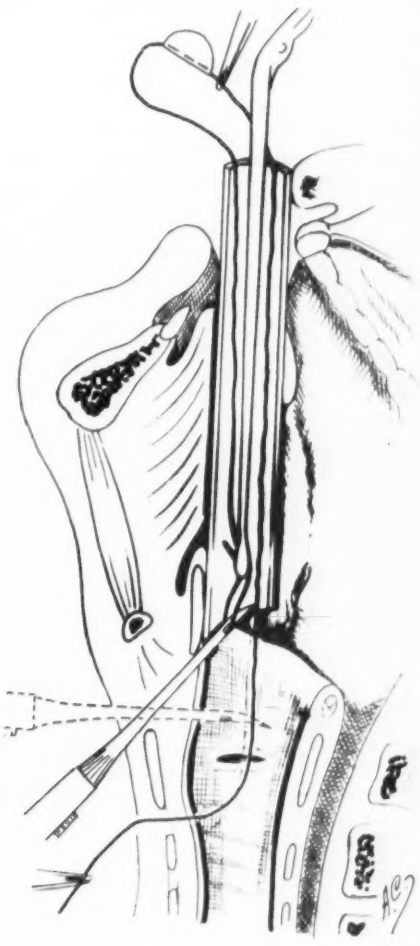

Figure 3

The thread should be black, if possible, so that it may be seen easily.

Technique

The following is an explanation of the procedure.

First Time.—By means of the endoscopic method the membrane is sectioned in its median part or along the edge of a vocal cord and is extirpated. This time the operation is done by common endoscopic procedures (Fig. 1).

Second Time.—A needle (e.g., straight Reverdin type) is passed at the level of the inferior edge of the thyroid cartilage on the median line of the neck, therefore, on the upper part of the cricothyroid space. This needle is passed through

the skin and the cricothyroid membrane. The endoscopist sees it appear in the tracheal slit beneath the anterior commissure of the vocal cords. It is then necessary to thread the needle with one of the ends of the thread fastened to the plastic plate. To do so, one must make a bow with one end of the thread and hold it with a laryngeal forceps. To thread the needle easily, the following movement may be made with the needle: The handle is moved downward so that the tip of the needle goes upward and appears in the laryngeal vestibule, passing between the vocal cords (Fig. 2).

Under the endoscopist's direction or looking through the tube himself, the surgeon is able to move the point of the needle so far upward that it may be easily threaded. After this is done, the needle is withdrawn, carrying one end of the thread outward through the skin of the neck.

The skin is then punctured once more with the needle in the median line at the level of the lower portion of the thyroid notch. The needle, addressed backward and slightly downward, touches the thyroid cartilage at the lowest part of the thyroid notch and appears in the larynx above the anterior commissure of the vocal cords. The movements first made with the needle are now repeated: The handle of the needle is drawn downward so that its point goes upward, and it is easy to thread it with the other end of the thread. The needle is withdrawn, carrying outward the upper end of the thread (Fig. 3).

Once both ends of the thread are out, one must pull them until the plastic plate occupies its position naturally in the anterior commissure, between the anterior part of both cords. This procedure must be carefully watched and, if necessary, guided with a pair of forceps by endoscopy.

When the plastic plate is in position, we place a piece of rubber tube between the external ends of the thread horizontally and tie both threads, or both ends of the thread, sufficiently tight to prevent the plastic plate, placed in the larynx, from moving (Fig. 4).

The laryngoscope is removed. The patient may eat and breathe freely, and in the case of an adult he is allowed to go home, having been instructed on the hygiene and care of the skin of the neck at the place where the threads are passed.

One month later in the case of congenital membranes and two months or more later in the case of cicatricial membranes, the external threads are cut, but the ends are held near the skin with Kocher's forceps. After this, a tube is introduced into the trachea, and the plastic plate is seized with a pair of forceps and forced out along the path of the larynx and mouth. Then all is finished.

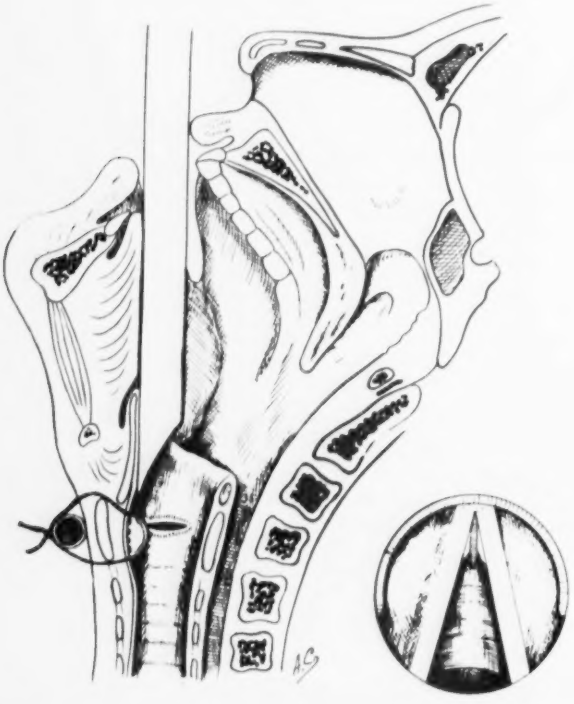

Figure 4

In some cases it is necessary to re-educate the patient in using his voice.

The number of cases we have treated is not very large, because we have been using this procedure only one year, but we have found it to be so simple, refined, and useful that we wanted to present it before our colleagues of America.

Summary

We have described a simple procedure in treating congenital and cicatricial membranes in the anterior part of the larynx in children and adults. A plastic plate is placed between the anterior portion of both vocal cords after an endoscopic section of the membrane has been performed. The plate is held in position by means of a thread which passes through it along one of its edges. The ends of the thread are passed above and below the thyroid cartilage in the median line. The plate is kept in position by tying both ends of the thread around an external rubber tube.

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Otosclerosis

An Index of the Literature, with Abstracts, and an Index of the Authors According to Subjects for 1954-1955

This is the eighth installment in the loose-leaf form for insertion in Volume IV, "Otosclerosis." It covers the literature for the years 1954 and 1955 and is published by the Central Bureau of Research of the American Otological Society, Incorporated.* As in previous years, it also contains a few abstracts not obtainable in time for the prior index.

Both original articles and abstracts in the various medical publications have been utilized in preparing this index.

The titles of articles are given in English and the names of the mediums of publication in the language of the original.

Only the opinions of the authors are given, and no endorsement or condemnation should be inferred because of the selection of the articles abstracted. During recent years so many papers on the fenestration operation have been published and they have become so repetitive in character that we have abstracted but a few.

A reprint of this installment with index of authors according to subjects and perforated for loose-leaf binding in Volume IV of "Otosclerosis" may be obtained for $1.00 from

Edmund Prince Fowler, M.D., *Editor*
140 E. 54th St., New York 22.

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Accepted for publication Aug. 2, 1956.

Special article.

*The Central Bureau of Research (originally the Committee on Otosclerosis) of the American Otological Society, Inc., is constituted as follows: Board of Trustees of the Research Fund: Edmund P. Fowler, M.D., Chairman, New York; Philip E. Meltzer, M.D., Secretary, Boston; Lawrence R. Boies, M.D., Minneapolis; Gordon D. Hoople, M.D., Syracuse, N. Y.; John R. Lindsay, M.D., Chicago; William J. McNally, M.D., Montreal, Canada; D. E. Staunton Wishart, M.D., Toronto, Canada. Member Emeritus: D. Harold Walker, M.D., Boston. Advisors to the Board: (legal) Samuel Lloyd; (financial) Walter C. Baker. Consultants to the Board: Hans T. Clarke, D.Sc., Department of Biochemistry, Yale University; Samuel R. Detwiler, Ph.B., A.M., Ph.D., Professor of Anatomy, College of Physicians and Surgeons, Columbia University; Stacy R. Guild, Ph.D., Johns Hopkins University; R. Lorente de Nó, Rockefeller Institute for Medical Research, New York; Ernest Glen Wever, Ph.D., Princeton, N. J.

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Albrecht, R.: Disturbances in the Tension of the Tympanic Membrane in Fenestrations and Their Prevention, HNO (Berlin) 4:239-242, 1954.

The author describes the loss of hearing which is observed between the fourth and the ninth postoperative month after an initial improvement in the hearing as due to diminished tension in the tympanic membrane. In these cases bone conduction is unimpaired and Eustachian inflations may result in temporary improvement as may a wet swab placed on the tympanic membrane.

Alexander, L. W.: Pitfalls of Fenestration Surgery, Eye, Ear, Nose & Throat Month. 33:96-103, 1954.

One of the pitfalls in fenestration surgery is the temptation of some surgeons to be content with a standard of improvement which is really too low to be considered worthwhile.

Bergman, M. L.: Otosclerosis in Identical Twins: Correction of the Number of Paris Heretofore Reported and Report of an Additional (the Seventeenth) Pair, A. M. A. Arch. Otolaryng. 59:316-318, 1954.

Berlendis, P. A., and Negri, M.: The Possibility of Preventing Closure of a Bone Fistula by Means of Autografting a Block of Bone with Preformed Canal in the Center, Arch. ital. otol. 66:320-332, 1955.

Small cylinders of bone were taken from the bony palate and implanted in the frontal bone in order to determine the reactions they caused. It was found that, in spite of the hole in the cylinders, when they were implanted rapid tissue necrosis took place and there was a replacement by newly formed connective tissue which extended inward from the borders and at longer or shorter intervals obliterated the artificial canal. This would make it appear that the insertion of such cylinders of bone can be of no use in operations to relieve the deafness of otosclerosis.

Brunner, H.: Attachment of the Stapes to the Oval Window in Man, A. M. A. Arch. Otolaryng. 59:18-29, 1954.

The author reviews stabilizing factors in the stapedovestibular articulation and believes that they are more complicated than has previously been thought. He reviews the effects following stapedectomy.

Cawthorne, T.: Otosclerosis, J. Laryng. & Otol. 69:437-456, 1955.

Forty-seven per cent of 2000 hard of hearing adults examined in a special clinic, and fitted with hearing aids, were found to have otosclerosis. A review of 2000 cases of otosclerosis during the past 10 years revealed that 10% had a pink glow through the tympanic membrane. The author suggests that it is not an altered vascularity resulting from an otosclerosis which tends to cause a lack of cerumen and a reduced sensitivity of the external auditory canal, but rather the result of repeated otoscopic examinations. The author believes that whereas the movement of the stapes is usually impeded, it is not often immobilized by the otosclerotic process. He suggests that "stiffness of the stapes" is a more accurate description than fixation or ankylosis, the latter two implying immobility, which is found only in advanced cases. It is felt that the underlying cause of otosclerosis is the effort of the body to change cartilage into bone. The author states that the site of election in the otosclerotic process is the fissula ante fenestram, which may contain an immature form of cartilage which tends to be changed into bone, particularly at such times when bone-growth-producing substances are circulating in the body, i. e., during adolescence and the later months of pregnancy. This coincides with Siebenmann's opinion that otosclerosis is really an attempt by the body to add bone to the labyrinth, which is a normal process in every other bone but abnormal in the labyrinthine capsule. Wever and Lawrence are quoted concerning the mechanics of the impedance by otosclerosis, and the author believes that for a successful fenestration operation there must be mobile

windows on each side of the basilar membrane. Such would be the case if the round window were occluded but the oval window were free, in which event the fenestration operation would produce two mobile windows on the vestibular side of the basilar membrane. In this event there would be a fluid wave stimulating the vestibular mechanism without affecting the cochlea mechanism to any great extent. This may be an explanation of the drop in hearing following some fenestration operations with severe vertigo and a very active fistula sign. The author theorizes that the reason the Tullio phenomenon is absent after the fenestration operation may be the possibility that the oval window is not readily moveable. If the oval window is, as usual, moveable postoperatively the acoustic stimulus will cause a vestibular response and therefore the Tullio phenomenon. For these reasons the fenestration operation should not be carried out when the normal movement of the stapes is not impeded. Postoperatively closure of the fenestra is not common: 8.5% in cases operated upon more than two years ago. In an additional 13% of cases there was an active fistula sign retained but no improvement in hearing.

Daly, S.; Goldstein, L. J.; Heller, M.; Anderman, B., and Ezekiel, M. M.: Mobilization of Middle-Ear Structures Through the Eustachian Tube, A. M. A. Arch. Otolaryng. 62:187-197, 1955.

A technique for mobilizing the middle-ear structures by passing bougies through the Eustachian tube is described. The subsequent improvement in hearing lasted for two months.

Damon, A.; Fowler, E. P., Jr., and Sheldon, W. H.: Constitutional Factors in Otosclerosis and Ménière's Disease, Tr. Am. Acad. Ophth. 59:444-458, 1955.

"As part of a long-term, continuing study of otosclerosis and Ménière's disease, 200 patients have been studied constitutionally. There is an unexplained deficit of Negroes in both groups. The white patients followed the expected age, sex, and racial distributions for these diseases and for this patient population, drawn from both private and clinic practice. The chief positive findings to date are that the typical patients with Ménière's disease and with otosclerosis differ significantly in mesomorphy (Ménière's disease, more mesomorphic), ectomorphy (Ménière's disease, less ectomorphic), and variability of mesomorphy (otosclerosis, more variable). All of these differences are statistically significant among the women, but due to the shortage of men with otosclerosis, they are merely suggestive among the men. However, in all these respects men and women patients follow the same trend. The diagnostically intermediate patients with atypical Ménière's disease and otosclerosis with nerve deafness are likewise intermediate physically and in respect to age. The practical and theoretical significance of these differences in physique, which are by no means absolute or extreme, is discussed."

Dohlman, G.: The Mechanism of the Fistula Test, Acta oto-laryng. (Supp.) 43:22-26, 1953.

The mechanics of the fistula test are explored, particularly the position of the fistula and the effect of inflammatory processes on the fluid contents of the canal.

Farrior, J. B.; Bagby, R. A., and Thomas, C.: Fenestration Operation Analyzed for Nonfenestrating Otologist: Experiences with Four Hundred Forty-Five Fenestrations, A. M. A. Arch. Otolaryng. 59:1-17, 1954.

Femenic, B.: Labyrinthine Surgery, Lijecn. vjesn. 77:62-68, 1955.

The author discusses the solution of several problems concerned with the noninflammatory labyrinthine affections (otosclerosis and Ménière's disease). He attempts to avoid the closure of the surgically made labyrinthine opening by the procedure which he first proposed in 1948. He preserves the endosteum in making the new window, and this endosteum is incised along the longitudinal axis of the artificially formed window. The two endosteal layers are then placed on the edge of the bony window and fixed in this position. He avoids in this way any apposition of bone or connective tissue to the bony edge of the new window. Shambaugh called such a window an "endosteum-hemmed fenestra." When in a case of labyrinthine hydrops treatment fails, the endolymphatic space is evacuated into the perilymphatic space. In three patients vertigo was completely abolished by this method and the hearing in the ear operated upon was preserved.

Femenic, B.: Indications and Results of Fenestration in Otosclerosis, Med. glasn. 9:77-79, 1955.

In the author's patients who had been under observation for more than five years following fenestration the improved hearing had persisted for this length of time. A few showed some slight fluctuations of the hearing in the ear operated on (10 db. in the range most useful for speech). The nontreated ear, however, exhibited a progressive loss of hearing and marked neural deafness.

Fine, J.; Bentel, H., and Meyerovitz, L.: Controlled Hypotension in Fenestration Operations: Experiences in Twenty-Seven Cases, South African M. J. 28:101-102, 1954.

The authors use hexamethonium bromide and procaine amide, as well as the reverse Trendelenburg position of the head, to produce hypotension. The systolic blood pressure is lowered to 50-65 mm. Hg, and a satisfactory, bloodless field is obtainable. There are some dangers, namely: (1) excessive fall of blood pressure with irreversible circulatory failure, (2) coronary or cerebral thrombosis, (3) renal failure, (4) necrosis of the liver, (5) blindness, and (6) reactionary hemorrhage. The dosage of hexamethonium varies from 50 to 250 mg. plus 1 to 3 ml. of procaine amide. It is evident that there are hazards and that skilled teamwork is of the greatest importance.

Fowler, E. P., and Fowler, E. P., Jr.: Somatopsychic and Psychosomatic Factors in Tinnitus, Deafness and Vertigo, Ann. Otol. Rhin. & Laryng. 64:29-37, 1955.

The authors set forth their philosophy and methods of management and treatment as based on extensive clinical experience and experimental research. They studied the somatotypes, in other words, the body types and emotional make-ups, and endeavor to interrelate the emotional episodes with the appearances or exacerbations of the disease in each type. They find that patients with Ménière's disease, sudden deafness, or otosclerosis can frequently, with high statistical validity, be classified into certain body types, and that the

closer these people resemble certain prototypes the severer their symptoms will tend to be and on smaller provocation, and the more assistance they will need from an understanding physician. The authors' examinations and follow-ups are given in detail. It is warned that otologists or other physicians and surgeons should not employ medicine or surgery or both as complete remedies, because they only supplement, not replace, the inherent processes of the body. They state that the designation "psychosomatic" or "emotional" is an oversimplification. Every disorder or disease affects not only the psychic but also the soma to some extent. "Somatopsychic" is often what the physician really means when he uses the above-mentioned terms.

Frazer, J. P.: Otosclerosis: Its Recognition and Treatment, Hawaii M. J. 14:215-217, 1955.

Friedmann, I., and Radcliffe, A.: Otosclerosis Associated with Malignant Melanoma of the Ear, J. Laryng. & Otol. 68:114-119, 1954.

Goodhill, V.: Trans-Incudal Stapedolysis for Stapes Mobilization in Otosclerotic Deafness (Under Audiometric Control): A Surgical Technique for Improvement of Hearing in Otosclerosis Is Described, Utilizing New Methods in the Stapes Approach, Laryngoscope 65:693-710, 1955.

Hall, I. S.: The Revision Fenestration Operation, Acta oto-laryng. 43:163-166, 1953.

In 36 instances 76% continued to show improvement in hearing after two years. In some cases examination of a fistula which had closed showed a cartilage implantation overgrown by periosteal bone. In other cases the cartilage became fixed by an ingrowth of bone or connective tissue. When no cartilage was used the fistula closed by growth of connective tissue, in the deeper layers of which bone cells could be found. The author believes that the fistular closure takes place by the formation of connective tissue in the accumulated serum and blood underneath the flap and not by an ingrowth of the fistula edges. Bone is formed in the connective tissue thus accumulated. Controlled blood pressure is of importance. It returns to normal within three to four hours following the operation.

Hall, I. S., and Ogilvie, R. F.: A Histological Study of Otosclerosis in Identical Twins, Acta oto-laryng. 44:446-448, 1954.

Halliday, G. C.; Raffan, H. D., and Mackay, R. G.: Some Aspects of Five Hundred Fenestration Operations, M. J. Australia 1:597-601, 1955.

Henner, R.: Bone Conduction Studies After Fenestration Surgery and Predictions of Hearing Results, A. M. A. Arch. Otolaryng. 59:300-305, 1954.

The author's bone-conduction measurements showed an improvement and were compared with those obtained by Carhart, McConnell, and Nilsson. The author believes that although he can not predict results mathematically the tests can be of value in classifying cases for the purposes of better understanding of the different types of hearing loss.

Hladky, R.: Radiographic Appearance of Resorption of the Bony Labyrinth, CSL Otolaryng. 4:195-200, 1955.

Hlavácek, V.; Opplt, J., and Musil, J.: A Study of the Blood Proteins Spectrum in Otosclerosis, Casop. lék. cesk. 94:1277-1279, 1955.

The authors describe the electrophoretic spectrum of the blood serum proteins in uncomplicated otosclerosis. In two-thirds of the cases they found a characteristic increase of middle globulin fractions (α, β), "most frequently jointly but also singly." They consider it essential for a proper interpretation of the proteogram to supplement the findings with an estimation of the lipoproteins and glycoproteins of the blood.

House, H. P.: Surgical Repair of the Perforated Ear Drum, Ann. Otol. Rhin. & Laryng. 62: 1072-1082, 1953.

The author describes a method for repairing eardrum lacerations occasioned during the fenestration operation. Stellate incisions are made into the drum membrane at equally spaced intervals, allowing it to drop on to the medial wall of the middle ear. After removal of the mucous membrane from the promontory a thin, full-thickness graft is placed over the denuded bone. This, it was found, adhered to the promontory but the drum remained mobile between the graft edges and the annular ring, in this way creating a small peripheral sealed-off middle-ear air space. A satisfactory improvement in hearing was obtained in three cases which the author describes. It is suggested that the procedure may also have some value in closing perforations in inactive chronic otitis media.

Hunter, K.: Otosclerosis and a Review of Fifty-One Fenestration Operations, Ulster M. J. 23:23-26, 1954.

Hutchinson, C. A.: Cortisone in Fenestration Surgery, J. Laryng. & Otol. 68:189-190, 1954.

The author is of the opinion that cortisone topically applied promoted healing after the fenestration operation. However, it was interesting to note that out of 32 cases 11 later developed keratosis.

Hutchinson, C. A.: Radiography as an Aid to Differential Diagnosis Between Otosclerosis and Chronic Adhesive Process, J. Laryng. & Otol. 69:617-624, 1955.

The preoperative differential diagnosis between a chronic adhesive immobilization and an otosclerotic ankylosis is again stressed in this article. A clinical examination, a complete history, audiometry, and x-rays help to differentiate the otosclerotic labyrinthine capsule lesion from that found with purely adhesive processes. Modified Townes' and Stenver's projections are described in detail together with important points in differential diagnosis and x-ray interpretation.

Jauerneck, A.: The Late Results of the Fenestration Operation, HNO (Berlin) 5:12-16, 1955.

If the improvement in hearing following the fenestration operation endures for more than two years most authors consider the improvement permanent. The author found in 120 patients operated upon more than two years previously that there was still improved hearing in 90%. In these same patients during the first two years following their operation 95% qualified as successful. The author does not consider a chronic discharge from the cavity as a

cause of failure. In his patients examined after an interval of two years 50% were able to hear the conversational voice at a distance of 18 ft.

Jongkees, L. B. W.: Cupulometry, Minerva otorinolaring. 4:125-131, 1954.

The classical Bárány tests are discussed, but small stimuli are preferred because of their greater usefulness, less discomfort, and minimum dangers, also because of their application to a broader field. Cupulometry gives more information than the older, single-stimulus tests, not only concerning sensation of rotation and nystagmus but also in its ability to differentiate between two types of dyssymmetry (crossed and parallel lines) of the nystagmus. Many interesting facts have been revealed in otosclerosis and in head traumas, streptomycin sulfate intoxications, and in fenestration cases.

Khanamiroff, A. R.: Fenestration of the Labyrinth, Vestnik oto-rino-laring. 3:34-39, 1955.

Kroath, F.: Problems of the Physiology and Pathology of the Internal Ear in the Light of Observations Made at Fenestration, Arch. Ohren- Nasen- u. Kehlkopfh. 168:89-100, 1955.

The author calls attention to the fact that the European otologists operate on a wider range of indications than American operators, and he is of the opinion that this range should be widened. He proposes the following wider indications:

1. In order to obtain the advantage of even partial improvement in hearing because of the psychical benefits which may thereby be secured, while more economical use of a hearing aid is rendered possible.

2. To raise the level of binaural hearing, since both the unoperated ear and the ear operated on participate in the hearing improvement. Though this is admittedly a controversial point (Lempert, Shambaugh, Woods, and others deny that it occurs), the author (*a*) produces abundant anatomical and physiological reasons for contralateral hearing improvement (the experiments of Guttich, Rosenzweig, and others show each cochlea is in connection with both cortical centers; Venker has shown that the sympathetic supply of both ears proceeds from the plexus around the circle of Willis; the closeness of the cochleovestibular relation has been firmly established by Guttich, Tullio, Kraus, Kobrak, and Potzl) and (*b*) cites numerous clinical observations in support of its occurrence made by Martin, Kopetzky, Hicquet, de Graf-Woodman, Venker, Jongkees, Schubert, Mayoux, Menck-Thygesen, and Kroath.

3. Because of the uncertainty of prognosis for all tone levels, and, in particular, to make use of the reversible internal ear component (in regard to which the author quotes Schubert, Jatho, Campbell, Kraus, Saltzmann, Markl, and Kroath).

4. To arrest the progress of the otosclerotic process (Lempert, Shambaugh, Simson Hall).

5. To ensure general improvement in hearing through stimulation of the vestibular system.

6. To step up automatic hearing by influencing the sympathetic system.

Lempert, J.: Surgical Remobilization of the Inner Ear Fluids for the Improvement of Hearing in Middle Ear Deafness, Tr. Am. Acad. Ophth. 59:166-174, 1955.

The author is of the opinion that if hearing is improved by loading the drum membrane with a swab the fenestration has not produced optimal remobilization of the fluids of the inner ear. However, optimal remobilization has been produced in patients in whom the swab did not lead to improvement of hearing.

Lidén, G.: Indications for Fenestration Operation in Otosclerosis, Svenska läk.-sällsk. forhandl. 52:2017-2027, 1955.

Lindsay, J. R., and Hemenway, W. G.: Occlusion of the Round Window by Otosclerosis, Laryngoscope 64:10-19, 1954.

The authors describe a case of otosclerosis in a man aged 31 who was operated on by fenestration. Technically the procedure appeared perfect, but there was no improvement in his hearing. It is believed that this lack of improvement was due to an occlusion of the round window. They cite Wever as having found that this condition causes hearing loss comparable to stapedial ankylosis.

The authors also published eight photomicrographs of the right temporal bone of a dying woman, 35 years of age, showing an otosclerotic focus occluding 80% of the area of the round window. The patient died of an intercurrent disease before any deafness occurred. The authors concluded that in otosclerosis deafness may in rare instances be due to occlusion only to the round window.

Livan, M.: Test of the Round-Window Function, Arch. ital. otol. 66:816-829, 1955.

The author believes that none of the instrumental tests now used for the clinical diagnosis of round-window impedance are satisfactory, and he criticizes the procedures now used for this purpose.

McFarlan, D.: Testing for Otosclerosis and a Description of a Quantitative Gelle Test, J. Laryng. & Otol. 67:740-744, 1953.

The author believes that the modified Gelle test has some quantitative value in that it may afford an idea of stapes fixation. He describes a method of changing the pressure in the external meatus and middle ear by placing the finger in the patient's external auditory meatus and noting the changes in loudness when a vibrating fork or audiometer bone-conduction receiver is placed on the mastoid process. He uses the frequency of 1000 with a loudness intensity of 5-10 db. above the bone-conduction threshold. He believes that if there is no loudness change it indicates a complete stapedial fixation, and vice versa. Raising the tone of the audiometer may show no loudness change for those tones only a little above bone-conduction threshold, but definite loudness changes for tones well above threshold.

Maggio, E.: Clinical and Pathogenic Aspects of the Blood Pressure in Otosclerosis, Arch. ital. laring. 61:24-32, 1953.

In 23 cases of otosclerosis this study revealed a hypotensive condition in 70% ranging from a maximum of 15-20 mm. to a minimum of 5-10 mm. of mercury, and involving both the systolic and the diastolic pressure as well

as the pulse pressure. In no case were values obtained higher than average normal. The author concludes that these findings, as well as the increase in basal metabolism, the diminution of the 17-ketosteroids, and the sympatheticotonic tendency found in the autonomic nervous system, suggest various dysfunctions in these patients associated with certain ear conditions.

Maggio, E.: Biological and Clinical Effects of Combined Treatment with Testosterone and Vitamin E in the Light of Modern Ideas on the Pathogenesis and Treatment of Otosclerosis, Arch. ital. laring. 61:65-122, 1953.

The author proports to show that combined treatment with testosterone and vitamin E is useful in otosclerosis. Clinical, biological, and 17-ketosteroid studies appear to show a "neurodystonic" syndrome. He agrees with what others have suggested, that otosclerosis represents a local expression of a neuroendocrine dysfunction.

Maggio, E.: New Data on the Pathogenesis and Treatment of Otospongiosis, Based on the Study of the Biological and Clinical Effects of the Combination of Testosterone and Tocopherol, Ann. oto-laryng. 72:409-418, 1955.

The author believes that the loss of hearing occurring in otospongiosis is of a purely functional nature and includes this form of otopathy among the "labyrinthoses." He discusses a study that he made of the biological and clinical effects in people with otospongiosis using vitamin E and the male sex hormone. The dosage varied with various persons but averaged 10 mg. of tocopherol acetate and 25 mg. of testosterone propionate per day. It was given in two cycles a year, each lasting 15-20 days.

The author summarizes his conclusions as follows: 1. Otospongiosis entails (*a*) an increase of basal metabolism; (*b*) decrease of the total urinary excretion of 17-ketosteroids; (*c*) decrease of serum cholinesterase; (*d*) arterial hypotension, and (*e*) a sympathicotonic tendency of the autonomous nervous system. 2. After the treatment, the phenomena mentioned above were normalized. 3. The clinicoaudiological effects of the treatment described were lowering of the sound perception threshold for air and bone conduction (to an average value of 15 db.), enlargement of the auditory field, functional restoration of completely inactive receptors, improvement of the intelligibility of speech and of subjective acoustic sensation, disappearance or attenuation of tinnitus, as well as marked improvement of the general condition.

The author states that the improvements obtained were not permanent, although some persisted for several months. He believes that even if no prolonged improvement was obtained the progressive deterioration of the hearing was stopped. He states that the patient with osteospongiosis suffers from neurodystonia of sympathicotonic nature, and from hyperfunction of the pituitary and thyroid glands. He believes the auditory organ of these patients is also dystonic as regards the nervous regulation of the blood supply of the neurosensorial elements (angioneurosis of the branches of the spiral artery). This results in vascular spasm in this region, which weakens the acoustic vasomotor reflex and disturbs the balance of the labyrinthine fluids intended to cause a hypertension therein. In the bone the opposite phenomenon, namely, capillary dilatation, occurs, and this can be demonstrated indirectly by a study of the bone conduction before and after treatment with vitamin E and the male hormone.

Maktav, Z.: Two Cases of Fistulae of the Labyrinth, Türk tib cem. mec. 21:526-532, 1955.

Marinho, R., Jr.: Surgical Treatment of Otosclerosis: Selection of Cases for Fenestration of the Labyrinth, and Prognosis, Rev. brasil. cir. 25:312-321, 1953.

When the frequencies most useful for speech (500, 1000, and 2000) show no loss by bone conduction such a finding is considered ideal for the fenestration operation. A loss of 20-25 db. may be caused by the absence of the chain of ossicles, and a loss of 30 db. is considered the maximum loss that can be endured fairly well in every-day occupations.

Marschak, A.: Changes in the Auditory Ossicles in Otosclerosis, Oto-Laryng. Israel 3:27-30, 1953.

This is a review of the literature on the conditions of the ossicles in otosclerosis. The author also describes a case of ankylosis of the malleoincudal joint.

Mathé, K.: Fenestration Operation of the Semicircular Canal, HNO (Berlin) 4:291-302, 1955.

The results in 100 patients operated on 1.75 to 3.75 years previously are discussed with a description of the morbid anatomical picture found in otosclerosis. The author obtained better results with a free Thiersch graft than with a pedicled flap.

Mayoux, Martin, Chossergros, and Lafon: The Clinical Exploration of the Fenestra Rotunda: Study of the Permeability of the Fenestra Rotunda, J. franç. oto-rhino-laryng. 2:212-215, 1953.

When cocaine was injected into the tympanum cavity it penetrated rapidly into the labyrinth and manifested this penetration after 10 to 20 minutes by the patient having episodes of intense vertigo and a loss of hearing, both of which lasted several hours. It was thought that the cocaine passed by way of the fenestra rotunda and that therefore the permeability of the membrane could be tested in this way. Before the tests it is imperative to verify whether or not the vestibular excitability was normal. The author thinks that if the fenestra rotunda appears to be impermeable one should then make two fenestrations instead of the usual one. In chronic suppuration the fenestra rotunda was found to be almost always impermeable, and the author thinks this explains the frequent involvement of the labyrinth in tubotympanic catarrh and its relative rarity in chronic otorrhea. Cocainization of the tympanum made it possible to determine the indications for operating for tinnitus. In other words, if transient relief was obtained section of the auditory nerve would then be expected to effect a cure. If there is no relief there is danger of repercussion affecting the superior neurones, which would make section of the nerve useless. The cocaine caused a rise in the threshold of hearing on the opposite side as well as on the side injected, and a loss in bone conduction up to 40-50 db. in certain persons. There is a discussion of the interdependence of the various factors involved.

Meurman, Y., and Meurman, O.: Stapes Mobilization in Otosclerosis: Primary Results and a Review of Sixty-Three Cases, A. M. A. Arch. Otolaryng. 62:164-172, 1955.

Using Rosen's method of mobilization the authors report improvement in hearing in 58.7% of 63 patients. A 20 db. improvement was taken as the criterion. The chief cause of failure was fracture of one or occasionally two of the crura.

Moretto, G.: Clinical and Statistical Report on Eighty-Three Cases of Fenestration Operation for Otospongiosis of the Ear, Giorn. Accad. med. Torino 117:117-121, 1955.

Mozota, R.: Indications for Surgical Treatment of Otosclerosis, Acta otorrinolaring. esp. 4:125-137, 1953.

Mozota Sagardia, J. R.: Use of Antibiotics in the Preoperative and Postoperative Treatment of Fenestrations Performed After Radical Mastoidectomy, Acta otorrinolaring. esp. 4:147-153, 1953.

The author covers the cavity with a skin graft six months postoperatively when the cavity is dry and well covered with epidermis. He states that fenestration can then be performed with total restoration of hearing. As the bone of the semicircular canal is very fragile, special care should be taken when there is a cholesteatoma and cortisone should not be applied locally.

Mozota Sagardia, J. R.: The Psychology of Deaf Subjects Before and After Fenestration, Clin. y laborat. 57:194-198, 1954.

Mozota Sagardia, J. R.: Pathogenesis of Otosclerosis, Rev. méd. cubana 66:273-284, 1955.

Nager, G. T.: A Pair of Female Identical Twins with Clinically and Anatomically Corresponding Otosclerosis and a Similar Gain in Hearing by Fenestration, Acta oto-laryng. 54:42-58, 1955.

It is pointed out that in interpreting genealogical trees in otosclerotic patients we are handicapped because the disorder is so frequently without symptoms because unless the anterior margin of the oval window is involved any otosclerosis present can only be diagnosed histologically.

Permin, M.: Fistular Labyrinthitis: Follow-Up on Ninety-Five Operated Patients, Acta oto-laryng. 45:416-425, 1955.

The author summarizes his paper as follows: "During the ten-year period 1945-1954 a total of 856 patients with chronic suppurative otitis media have been admitted to the Ear Clinic of the Copenhagen City Hospital. Of the operated cases 108, or about 13 per cent, exhibited fistular labyrinthitis. Ninety-five have been followed up for periods ranging from 10 years to 4 months. Before operation 83 had exhibited a positive fistular reaction, whereas in 12 a fistula on the lateral semicircular canal was not revealed until at operation. In all 12 the caloric reaction had been positive prior to operation. The labyrinthine lesion is of almost equal frequency in males and females and in the right and left ear. Aural symptoms had been present for more than one year in 89 cases. Vertigo had been observed before the operation in 60. Fifty-six patients were over 40 years of age. . . . Operation revealed cholesteatoma in 58 and only osteitis in 37. Since the operation 51 patients had not had discharge, but follow-up showed that vertigo was equally common in the absence of discharge as well as in the presence of constant or periodical discharge. Spontaneous nystagmus was found in 42 patients before the operation,

directed with almost equal frequency towards as well as away from the affected ear. Acoustic function was abolished in 6 before the operation. At follow-up 48 patients, or 50 per cent, had no serviceable hearing. Labyrinthine fistula was found at operation in 62. A positive fistular reaction was elicited in 83 patients prior to operation, in 80 by compression and in 55 by aspiration with the Politzer bag, in 29 by pressure on the tragus, and in 6 by pressure on the vessels of the neck. It was typical in 74 cases, reversed in 8, and atypical in 1. At follow-up the fistular reaction was present in only 25. Out of 12 patients showing fistula on the lateral semicircular canal, but no fistular reaction prior to operation, 4 had typical fistular reaction at follow-up. Caloric reaction was normal in 59 cases at follow-up, abolished in 10 (+8?), and atypical in 26 (−8?)."

Pursiainen, K. E.: Fenestration and Experimental Nystagmus: Studies by Rotation, Caloric Stimulation and Fistula Tests, Acta oto-laryng., Supp. 112, pp. 1-97, 1954.

An extensive survey is presented of the vestibular reactions following fenestration. Bárány tests were used, the patient being rotated 10 turns in 20 seconds. No differences were found preoperatively between the results obtained for the subsequently unoperated ear and the ear operated on. In the postoperative tests the postrotational nystagmus in a large proportion of the cases showed a shorter duration toward the side operated on than toward the unoperated side. In the cases operated on bilaterally no nystagmus was elicited after the second operation in spite of the fact that the patient may have shown a positive response after unilateral fenestration following testing in the usual way with the head erect. The author concludes that in a large proportion of cases fenestration altered the response of the horizontal semicircular canal to the rotation test.

With the use of the air caloric test nystagmus was diminished after operation and in the fenestrated ear the direction of nystagmus was reversed by bending the head forward in 2.2% ; in 94.9% of the cases there was no reversal, the nystagmus continuing in the same direction. Nystagmus was always elicited by postoperative caloric stimulation. The author concludes that the fenestration operation causes a change in the response of the vestibular apparatus in a large proportion of cases. With the use of air compression in 135 cases nystagmus was produced: homolaterally in 112 cases and heterolaterally in 18 cases. It varied from side to side on repetition of the test in four cases. In one instance there was a vertical downward nystagmus. The author discusses the relation between cupular deviation and the direction of the nystagmus. In some instances other factors besides the cupular deviation determine the direction of the nystagmus.

Rebagliatti, H., and Santoro, A.: A Technique for Fenestration, An. oto-rino-laring. Uruguay 23:91-97, 1953.

A simplified fenestration procedure is described which requires no special equipment except that currently used in aural surgery. The author does use Cameron's lenses.

Rosen, S.: Mobilization of the Stapes to Restore Hearing in Otosclerosis, New York J. Med. 53:2650-2653, 1953.

The author submits evidence to prove that in otosclerosis the ankylosed footplate of the stapes may be mobilized by manual manipulation with a probe. The procedure consists of first lifting the drum membrane out of its sulcus from 9 o'clock to 3 o'clock and folding it upward, thus exposing the short process of the incus, the stapes, and the stapedial tendon. A curved dental scaler is inserted above the incudostapedial joint until the superior crus of the stapes is felt close to the footplate. As the instrument descends the superior crus the operator feels a dent or depression, which is the neck of the stapes. The neck of the stapes can withstand heavy pressure without fracturing of the crura, and when pressure is made downward in the line of the tendon the footplate suddenly loosens and the hearing returns. The drum is then returned to its normal position, and the patient requires hospitalization for only one day. The operation is done under local anesthetic. The author states that he has observed no postoperative vertigo and no necessity for any after-treatment.

Rosen, S.: Simple Method for Restoring Hearing in Otosclerosis, Mobilization of Stapes: Case Reports, Acta oto-laryng. 44:78-88, 1954.

The author describes his method of endaural approach under local anesthesia. He asserts that in certain cases mobilization of the stapes can be accomplished to the extent that the hearing is restored, or at least improved. In one case he obtained an improvement of the hearing which lasted for a year. His procedure in no way interferes with subsequent fenestration operation should this be indicated.

Rosen, S., and Bergman, M.: Restoration of Hearing in Otosclerosis by Mobilization of the Fixed Stapedial Footplate: An Analysis of Results, Laryngoscope 65:224-269, 1955.

Rosen, S., and Bergman, M.: Improved Hearing After Mobilization of the Stapes in Otosclerotic Deafness, J. Laryng. & Otol. 69:297-308, 1955.

The authors discuss a modification of Kessel's operation which should be practiced on the cadaver. They describe a special set of instruments. The tympanomeatal flap is elevated following circumcision of the inferior moiety of the osseous portion of the external auditory meatus, and the notch of Rivinus is chipped away sufficiently to better expose the stapes. When the stapes is ankylosed it may be mobilized by pressure in the axis of the stapedial tendon without fracturing the crura. It fractures with an audible snap. The advantage of stapedial mobilization over fenestration is that a physiological ossicular conduction is restored. Moreover, it does not interfere with a subsequent fenestration procedure.

Scheer, A. A.: Restoration of Hearing in Otosclerosis by Transtympanic Mobilization of the Stapes: Preliminary Report of Fifty Cases, A. M. A. Arch. Otolaryng. 61:513-534, 1955.

This is a preliminary report of the results of 50 cases of clinical otosclerosis operated upon according to the "Rosen method." The author states that the Rosen method can restore hearing in otosclerosis. The stapes was found fixed in 94% and was mobilizable in 62%, but only 30% of those operated upon experienced a return of hearing to a serviceable level. In 32% of the cases the stapes was fractured because the author states it was too firmly ankylosed.

Histories and audiograms are shown. In two instances fixation returned but the stapes was remobilized with, again, a hearing loss to the original postoperative level. In 10 cases the chorda tympani was sacrificed, with a disturbance of taste which persisted to a slight degree.

Scheer, A. A.: Restoration of Hearing in Otosclerosis by Mobilization of the Stapes, Jornada med. 11:541-545, 1955.

Shambaugh, G. E., Jr.: Problems Encountered in Fenestration, J. Internat. Coll. Surgeons 20:736-740, 1953.

The author discusses in detail six factors which have emerged as significant in the osteogenetic closure of the fenestra. He has obtained an improvement of 5-10 db. in hearing by placing an ointment on the tympanic membrane and thus increasing the differential pressure between the window made by the fenestra and the round window.

Shambaugh, G. E., Jr.: Technic for Increasing Sound Pressure Differential Between Fenestra and Round Window to Enhance Hearing Improvement Following Successful Fenestration, Tr. Am. Acad. Ophth. 58:454-459, 1954.

The author believes that following the fenestration operation the patient hears by way of the fistula in the horizontal semicircular canal, and that in order to increase the difference in pressures between the new window and the round window Aquaphor (oxycholesterol-petrolatum ointment base) should be applied to the tympanic membrane. In 45% of his cases the hearing was improved by 5 db. or more. In a total of 274 cases the frequencies most important for speech improved 3.74 db., the greatest improvement being in the lower tones.

Shambaugh, G. E., Jr.: Fenestration—Past, Present and Future, Ann. Otol. Rhin. & Laryng. 64:149-160, 1955.

The author believes that future fenestration surgery will probably be concerned mostly with improved methods for preventing postoperative serous labyrinthitis, techniques for overcoming the residual impedance losses of hearing remaining after successful fenestrations, and more definite information regarding the permanence of the improved hearing. Postoperative serous labyrinthitis appears today to be the most frequent cause of failures, whether caused by hemorrhages of the labyrinth or infection of the cavity. With proper antibiotic therapy infection of the wound is very seldom seen.

It is illogical to believe that fenestration can retard cochlear nerve deterioration in cases of otosclerosis, although in certain instances there has been a better maintenance of cochlear nerve function in the fenestrated than in the opposite, nonoperated ear. The author concedes that the so-called "simplier mobilization of the stapes procedure" may prove to be an "optional preliminary procedure" for certain patients with incomplete stapes ankylosis.

Shambaugh, G. E., and Takahara, S.: A Clinical and Experimental Study of the Effect of Fenestration on the Labyrinthine Contents, Acta otolaryng., Supp. 123, pp. 1-32, 1955.

The authors believe that the chief cause of failure by osteogenetic closure is serous labyrinthitis, as evidenced by the immediate improvement following operation and the quickly developing subsequent depression. They made a classification based on 141 animal cases, indicating that there are five grades

of postoperative labyrinthitis, and they have attempted to correlate the histological findings in animals with clinical observations on their patients. Even though the surgery has been well done, some degree of labyrinthine reaction is usual, and bleeding into the fenestra is probably the main cause of the labyrinthitis. However, infection and other factors must also be considered. Microphotographs illustrate the grades of labyrinthitis encountered.

Stirling, J. B.: Anæsthesia with Hypotension for Fenestration, Brit. J. Anæsth. *27*:80-92, 1955.

To reduce hemorrhage during the last phase of fenestration operations the author makes use of a planned hypotension by administering pentamethonium and hexamethonium. Electrocardiographic studies revealed no disturbance of the coronary circulation and oximetric studies no inadequate cerebral oxygen consumption.

Suggit, S.: Closed One-Stage Fenestration, M. J. Australia 1:601-603, 1955.

A closed one-stage operation using a postaural approach is described, the fistula being covered with a split-thickness skin graft, the posterior meatal skin undisturbed. The technique used eliminates the prolonged cavity care necessary in endaural procedures like Lempert's. With the use of the closed postaural technique 64% of the 14 cases maintained a 30 db. level or better for at least six months. The author compares this with 55% of cases maintaining at least a 30 db. or better level in 93 cases operated upon by the endaural Lempert technique.

von Schulthess, G.: Surgical Treatment of Hardness of Hearing: Experiences at the Zurich Otorhinolaryngological Clinic, Deutsche med. Wchnschr. 80:681-684, 1955.

The two-stage fenestration was carried out on 400 patients, and statistics are reported concerning the results. There were 37 surgical failures; 76% of the patients obtained improvement for at least two years and 50% for five years. In only one out of three patients was tinnitus favorably affected. The hearing tests are illustrated in audiograms.

Vyslonzil, E.: The Possibilities and Limitations of Fenestration (as an Operation to Improve Hearing), Wien. med Wchnschr. 103:895-898, 1953.

Vyslonzil, E.: Observations and Results in Fenestrations, Monatsschr. Ohrenh. 88:161-169, 1954.

The author reports that in 200 cases of fenestration he found the stapes to be mobilized in 16. He observes that these may have been cases of spasm of the tensor tympani muscle (Kobrak). Nevertheless, in these cases fenestration produced an improvement in the hearing. If the membraneous labyrinth was damaged it would not necessarily cause total deafness, and in some instances even after such damage there was some hearing improvement and the disturbances of the equilibrium were slight. The author assumes that there is probably present a postoperative labyrinthine dropsy, but this causes but slight disturbance because any overproduction of endolymph may drain away via the fistula. There were wide variations in the transient postoperative impairments in hearing. The author thinks that these differences may be related to the extent of the otosclerotic process. He found that depression

could improve the hearing for about 90 minutes, even during the postoperative period of lowered hearing. This is suggestive of a postoperative hypertension in the labyrinth.

Zanotti, G.: Aspects of Hearing Physio-Pathology During the First Post-operative Period Following Fenestration, Ann. Otol. Rhin. & Laryng. 63: 69-80, 1954.

In 30 cases the hearing was tested 3 days, 8 days, and 30 days post-operatively. The author believes that the current concept of postoperative labyrinthitis should be modified because the trauma involved should cause irritation only in the postlabyrinthine spaces and should not involve the cochlear segment.

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Therapeutically Induced Paralysis of the Cricothyroid Muscle or Its Removal in Paralytic Laryngeal Stenosis

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In two recent articles [1,2] laryngeal stenosis produced in dogs by bilateral recurrent nerve division was reported to be relieved by inactivation of the cricothyroid muscle. This effect was obtained in either one of two ways: by cutting the motor branch of the superior laryngeal nerve at the site of its entrance into the muscle or by total removal of the muscle with additional resection of the inferior thyroid horn. The authors suggested the application of these experiments in the treatment of "bilateral abductor paralysis" as a substitute for the more complex current procedures. They did not refer to any similar experiments or therapeutical techniques in the literature. Identical experiments with insignificant technical differences were performed by numerous investigators in various species of animals many times during the 19th century, and in man during the last few decades.

Experiments with Animals

Legallois was the first to observe the stenosing effect of bilateral inferior laryngeal neurotomy in dogs, cats, rabbits, guinea pigs, and horses, demanding tracheotomy in cats and puppies (1812). His experiments were duplicated by Reid, Longet, Schiff, Traube, Arnsperger, Onodi, and numerous others. A comprehensive review is presented by Burger.[3] The releasing effect obtained by subsequent removal of the cricothyroid muscle or its motor nerve supply was noticed by J. Singer (1873) and confirmed by Vierordt.[4] Identical experiments were performed on a large scale by Richard Wagner (M.D., of course), 1890,[5] and by Michael Grossmann, 1897.[5] Grossmann in his experiments, on dogs and cats, used a specially constructed device which made possible the accurate measuring of the glottis to a fraction of a millimeter. He found that the glottis was narrowed by an average of 66.6% subsequent to bilateral recurrent nerve severance and to be widened by an average of 67.5% after cutting the superiors or removal of the cricothyroid muscle. The results of these experiments were the chief objection to the validity of Semon's[6] Law. They initiated a violent controversy between Semon and Grossmann—one of the most unpleasant chapters in the history of our specialty. It was not a scientific exchange of opposing opinions; it was in reality a sort of intellectual dogfight. Wagner's and Grossmann's results were confirmed with some minor differences by many of their contemporaries, although some interpreted their results in terms favoring Semon's concepts. Experimental cutting of the inferior and the two branches of the superior laryngeal nerves separately as well as in all possible combinations was performed by Lemere, 1933.[7] His results conformed with those of Wagner and Grossmann. In addition, it was shown that the inner branch of the superior laryngeal nerve does not carry motor fibers (in the dog). From recent studies by Vogel[8] we know that conditions in man are different.

Experiments in Man

Experiments identical with those at issue, but in man, were reported for the first time by Leichsenring and Hegener, 1924.[9] These authors using various techniques paralyzed the recurrent nerve for therapeutic immobilization of the vocal cords in laryngeal

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tuberculosis. The resulting positions of the vocal cords were not consistent. Hofer and Jeschek,[10] during operation upon unilateral laryngeal cancer, purposely cut the recurrent and the two branches of the superior laryngeal nerve. This was done on the uninvolved side and in various combinations. The results were the same as in animals.

The authors mentioned that in a lesion of the vagus at the jugular foramen the vocal cord appeared immobilized in the cadaveric position. This conforms with identical observation previously reported by New.[11] Studies similar to those of Hofer and Jeschek were reported recently.

Semon's Law

As already mentioned, these experiments were presented as the chief arguments in the controversy with Sir Felix Semon concerning his law, which is briefly recalled:

Semon announced his law in 1881, which after several amendments stated: In the course of a gradually advancing organic lesion of the recurrent nerve or its fibers in the peripheral trunk of the vagus, three stages can be observed. In the first stage only the abductor fibers are damaged. The vocal cords approximate the midline; adduction is still possible. In the second stage, additional contracture of the adductors occurs and the vocal cords are immobilized in the median position. In the third stage, the adductors become paralyzed. The vocal cords assume the cadaveric position. (The term "cadaveric" was originated by von Ziemssen[12] and has been criticized. Fein[13] in a study of 50 cadavers found the vocal cords in 10 different positions depending on whether the examination was done before, during, or after rigor mortis. None of these corresponded to the clinical cadaveric position.)

Factors Differentiating Semon's and Wagner-Grossmann's Concepts

It seems that the principal differences in these two concepts resulted from different views concerning the factors responsible for the persistence of adduction. The function of the cricothyroid muscle as an adductor was still questioned by some until finally proved by Wagner's experiments. Jeschek[14] only recently explained the adductor action of this muscle. He found in his dissections a direct ligamentous connection with the cricoarytenoideus lateralis. This, in my opinion, explains the release of tension as obtained by De Quervain when he cut the cricoarytenoideus lateralis in a case of complete recurrent nerve paralysis.[15]

Semon apparently did not believe in the adductor function of the cricothyroid muscle. Because of this he established a hypothesis to explain the persistence of adduction in the first and second stages, namely, that there is a proclivity of the abductor fibers to become diseased. Wagner and Grossmann, of course, believed in the adductor function of the cricothyroid muscle; Wagner even proved it by the experiments at issue. There was no need for a hypothesis when facts were on hand.

Numerous attempts were made by Semon and his advocates to support the idea of a biological inferiority of the abductor fibers on the basis of clinical, pathological, anatomical, myochemical, experimental, and, later on, phylogenetical and electromyometrical studies. Most of these results have been disproved. More recently King and Gregg[16] in their anatomical studies emphasized the frequency of the infralaryngeal site of the bifurcation of the recurrent nerve. This may be responsible for the exposure to surgical injury of the posticus fibers. These anatomical findings are confirmed by Morrison[17] but questioned by Jeschek.[14] They do not agree with Kressner's[18] findings. Objections to Semon's "Law" are progressively accumulating. However, even in our days, authorities of high esteem adhere to these concepts. Lemere[19] says (1934), "Semon's law is a definite law, stating that the function of the abduction of the glottis has a proclivity to disease. There are many misconceptions in regard to laryngeal paralysis. The tendency to discard well established principles of laryn-

geal innervation, such as Semon's law, in the attempt to explain certain clinical findings, is unscientific."

In my opinion, any "tendency" influencing scientific research, whether it is directed toward "discarding" or supporting "well established principles, is unscientific."

Semon's idea of a law governing the position of the vocal cords was preceded by an identical concept of Rosenbach, 1880.[16] By regular laryngoscopic examination he observed in a case of esophageal cancer, with recurrent nerve paralysis, the transition from the median to the cadaveric position. Gerhardt [20] created the concept of the "posticus" paralysis. For this reason Semon's Law is eponymized in the German literature as Rosenbach—Semon's Law and even the name of Gerhardt may be found sometimes included.

Factors Responsible for the Cadaveric Position

The experiments at issue indicate that the cadaveric position of the vocal cords depends on paralysis involving both the inferior and the superior laryngeal nerves. It may result from injury of both of these branches of the vagus or by a lesion of the vagus located above the branching of the superior laryngeal nerve.

The cadaveric position so frequently noticed in mediastinal lesions is explained by recent findings of Hofer. In a case of malignant goiter, the vagus was cut transversally. Histological examination of the nucleus ambiguous showed degenerative changes of the entire nucleus involving all neuraxons. This retrograde degeneration is offered by Hofer [21] as an explanation for the cadaveric position seen in lesions of the vagus below the branching of the superior laryngeal nerve.

Therapeutical Applications

A. Inferior Laryngeal Neurotomy.—The idea of therapeutical applications of Semon's theory or of Wagner's experiments for relief of midline fixation in cases of paralytic laryngeal stenosis was originated by Ruault, 1893.[15] It occurred to him that by changing the midline position into the cadaveric, at least on one side, a satisfactory airway could be established. This goal, on the basis of the two opposing ideas, could be approached in either of two ways: Following the teaching of Semon, by cutting the recurrent nerve, converting in this way the second stage to the third. On the basis of Wagner's experiment, one should expect the same result by cutting the superior laryngeal nerve. The case of a tabetic, tracheotomized for bilateral midline fixation, became for Ruault the doctor's dilemma. The patient threatened suicide if he could not be relieved of his cannula. Ruault decided to perform recurrent nerve division. No change was obtained. ("Le larynx était absolument symétrique, sanse trace d'hemiplegie.") Ruault after three weeks suggested cutting the superior laryngeal nerve. The patient hesitated and died of asphyxiation before anything could be done.

Since then the inferior laryngeal neurotomy was performed in two cases by Klestadt [22] and once by Leichsenring and Hegener [9] with identical and negative results.

B. Superior Laryngeal Neurotomy (Ramus Externus).—Cutting the ramus externus of the superior laryngeal nerve is the operation suggested in the two recent articles. It was performed for the first time, in 1909, by Martens [23] in a case of Grabower's.[24] The patient, a 23-year-old cigarette worker, was operated on four times for thyroid goiter alternately on either side. After the first operation the right vocal cord was fixed in the midline, while the left, on phonation, moved beyond the midline. After the fourth operation, in 1907, the patient became slightly dyspneic. She was then seen by Grabower, in 1908. He diagnosed bilateral posticus paralysis. Tracheotomy was done by Martens. Superior laryngeal neurectomy was considered by Grabower. However, it was decided to wait for three months because of the possibility of a spontaneous recovery. After three months, since no change was seen, the operation was done. A

2 cm. piece of the left superior laryngeal nerve was removed. After one-half hour the left vocal cord was seen 1 mm. distant from the midline. After four days the distance from the midline was 2-3 mm. After six weeks the cannula was removed. No dyspnea appeared, even on exertion after four months. Grabower noticed at the last examination that the right vocal cord was fixed in the midline. No active movements of left, except for up-and-down movement during expiration and inspiration, were noted. The voice was hoarse. Maximum width of the glottis was 3 mm.

Comment: One can assume that with the first operation a right recurrent nerve lesion occurred, followed by midline fixation. At the fourth operation the left recurrent nerve was injured. The vocal cord gradually approximated the midline until tracheotomy became necessary. Superior laryngeal neurectomy put the left vocal cord in the cadaveric position with a satisfactory airway.

Additional Favorable Reports

Katzenstein[25] mentions a case of Grabower with bilateral posticus paralysis, referred to Killian, who after cutting the external branches of both superiors noticed widening of the glottis and improvement of dyspnea. No details are presented. Two successful cases are mentioned by Leichsenring and Hegener.[9] Bilateral median position appeared subsequent to therapeutic alcohol injection into the recurrent nerves. Since dyspnea persisted, procaine was injected into the superiors, with immediate relief.

Superior Laryngeal Neurotomy (Ramus Internus)

Amersbach[26] mentions that Killian obtained relief of dyspnea in a case by cutting the inner branch of the superior laryngeal nerve. The same result was noticed in a case of Onodi.[26] However, Mehring and Zuntz[26] reported on relief of dyspnea achieved simply by cocainizing the larynx. R. Hofmann[26] successfully injected alcohol into the ramus internus. It is assumed that in these cases a reflex contracture, so frequently seen in paralytic laryngeal stenosis, is responsible for the dyspnea. Interrupting the afferent limb of the reflex arc cuts the reflex. However, in view of the recent findings of Vogel,[8] who proved the existence of motor fibers passing to the arytenoideus en route of the ramus internus, I would suggest the possibility that the effect could be ascribed equally well to paralysis of the arytenoideus.

Failures of Cricothyroid Elimination

It seems that unfavorable experiences are rarely reported. Only two reports of this kind were found. One was presented by Leichsenring and Hegener.[9] Subsequent to a two-stage bilateral thyroidectomy, performed within an interval of one year, a bilateral midline fixation appeared. Six months later a cricothyroid myectomy was done, without relief.

Another case is reported by Amersbach[26]: A bilateral midline position was noticed subsequent to thyroid operation performed somewhere else. "When the patient came under my care there were already secondary changes of the ligaments and joints of such a degree that interruption of superior and inferior laryngeal nerves was without effect. I injected into both nerves 1% [procaine] Novocaine without producing any change of the vocal cord position. In addition I cocainized the larynx with a 20% solution. Elimination of laryngeal sensitivity appeared essential to me with regard to the opinion of Mehring and Zuntz."

It seems that unpublished failures were commoner than the reported successes. Thus the procedure was gradually abandoned but not forgotten. Lemere, 1934,[19] suggested that in cases of bilateral midline position before resorting to tracheotomy "an effort be made to relax the cricothyroid by paralysing the external rami of the superior laryngeal nerves." He adds: "This has been done for the relief of dyspnea caused by recurrent nerve paralysis (Terracol)." He also refers to the reports of Grabower, etc., as men-

tioned above. Numerous references to the work of Lemere appeared in the English literature.

Factors Possibly Responsible for Failure and Success of Cricothyroid Elimination

One wonders why this technique, which appears regularly effective when experimentally performed in man and in animals, was a therapeutic failure, with a few exceptions. It would seem that if one knew the factors responsible for these differences one could probably establish criteria for selection of the method appropriate in the individual case.

An approach to the solution of this problem may depend on answering two fundamental questions:

1. What are the factors responsible for opening the glottis?

2. What are the factors interfering with opening the glottis?

A brief review concerning matters of functional anatomy might be advisable.

Functional Anatomy

The function of each of the individual muscles of the larynx appears of minor importance in this concern. This discussion can be restricted to correcting a few mistakes which occurred in the second article [2] and its recent reproduction. These mistakes appeared in the list tabulating the nerve supply of the intrinsic laryngeal muscles and their action on the vocal cords.

Corrections

1. It is not the external but the internal branch of the superior laryngeal nerve which provides additional nerve supply for the arytenoideus (misquoted from Clerf and Baltzell [27]).

2. The action of the arytenoideus is not to produce tension upon the vocal cords. It is adduction of the arytenoids, thus closing the cartilaginous part of the glottis.

3. The action of the thyroarytenoid is not abduction. Its external portion is responsible for adduction, its inner portion, also called vocalis muscle, for tension.

These corrections, I believe, are mandatory in order to prevent the further propagation of erroneous statements.

Correlation of Muscle Group Action and Vocal Cord Positions with the Three Principal Types of Respiration

In the present discussion our interest is directed predominantly to the part played by the different muscle groups responsible for the position of the vocal cords, and their influence upon the shape of the glottis as it appears under normal conditions during the three principal types of respiration.

The laryngeal muscles are conveniently classified under three functional groups: tensors, adductors, and abductors. The muscle groups involved in respiration are, of course, the adductors and the abductors. The function of the tensors is negligible in this concern. The three principal positions of the vocal cords during respiration are median, lateral, and the intermediary, or cadaveric, position. Terms based on minor differences, such as (para) median, extreme lateral, prelateral, etc., are of minor significance.

The three principal types of respiration include (A) quiet respiration, (B) forced expiration, and (C) forced inspiration.

Muscle groups involved in the three principal types of respiration and the respective positions of the vocal cords are as follows:

A. In quiet respiration: No activation of adductors or abductors occurs. Both groups are relaxed. The vocal cords are in the cadaveric position.

B. In forced expiration: Abductors are relaxed, adductors are activated, vocal cords are in the median position.

C. In forced inspiration: Adductors are relaxed, abductors are activated, vocal cords are in the lateral position. This analysis brings us closer to the answer to our first question: What are the factors responsible for opening the glottis?

Mechanism Responsible for Opening the Glottis

The conclusion to be drawn from this analysis is there does not exist a muscle group which by its action opens the glottis. There does not exist a muscle which by its action can justify the term "opener of the glottis."

It would be frivolous on my part to make such a statement purely on speculative grounds. This is a proved fact. Grossmann, 1898,[28] showed experimentally that opening of the glottis does not depend on the action of any muscle. After removal of both posticus muscles or cutting their motor nerve fibers or doing both, lateral movements as far as the cadaveric position persisted. The animal was not dyspneic during quiet respiration. The condition was not changed when the cricothyroid muscles or anyone, or all, of the extrinsic muscles were removed. However, when the adductors were paralyzed by cutting the recurrent nerve at one side, the glottis was narrowed by approximations of the vocal cord toward the midline on the side of the recurrent nerve paralysis. Grossmann's experiments were confirmed principally by the identical experiments of Kuttner and Katzenstein,[29] Grabower,[30] Klemperer,[31] Stupka,[32] Herzog,[33] and others. Kuttner and Katzenstein[29] kept some of their animals alive for one year. No change of the glottis occurred.

From these experiments it becomes evident that the posterior cricoarytenoideus cannot be regarded as the "opener" of the glottis. It is its dilator. Grossman in his final conclusion says: "The previous idea that the abductor paralysis causes complete inability of the vocal cords to move laterally from the midline is wrong." And he adds: "The inspiratory movement of the vocal cord must be attributed primarily to the inhibition of the adductor tonus. There is almost no other explanation left."

"Almost" was correct. Grossmann had omitted consideration of one factor which is integrated in the mechanism of opening the glottis, namely, the elastic force provided by the membrana elastica laryngis inferior, also called the conus elasticus. More than a quarter of a century preceding Grossmann's experiments, von Luschka, in his classic work "Der Kehlkopf des Menschen," 1871,[34] presented conclusive evidence in this matter. A literal quotation from von Luschka follows:

> The musculus cricoarytenoideus posticus:
>
> After the glottis has been restricted to a small gap by means of the sphincter muscles, the reopening of the glottis occurs to a certain degree automatically with the release of the contraction of these muscles and the retraction of the tissue of the lower compartment of the membrana elastica laryngis. If there is need for a greater width of the glottis than the one we see in the cadaver and which is sufficient for quiet respiration, then, of course, the action of a dilating musculature becomes necessary. This is provided mainly by the bilateral musculus cricoarytenoideus posticus.

On the basis of the preceding discussion the following statements appear justified.

1. The abductors are not the openers of the glottis; they are its dilators.

2. Paralysis of the abductors is not responsible for the inability of the glottis to open.

3. The condition generally known by the name "bilateral abductor paralysis" does not result from bilateral paralysis of the abductors.

Accordingly, the answer to the question "What are the factors responsible for opening the glottis?" is release of adductor tonus and liberation of the conus elasticus.

We now arrive at our second question.

What Are the Factors Interfering with Opening of the Glottis (Under Paralytic Conditions)?

Recalling to mind the contents of the sporadic reports referred to before, two principal factors must be considered: (1) an active one and (2) a passive one. A combination of both may occur. These two factors are as follows:

1. (Active) Reflexly induced contracture of the adductors or, more specifically, of

the cricothyroid muscle. Such a hyperirritability exists, as we know, under conditions such as hypocalcemia, tetany, peripheral neuritis, etc. The increased negative infraglottic pressure adds to the constriction by aspiration of the vocal cords (Legallois,[3] Grossmann,[5] Neumayer,[35] etc.). Onodi [35] assumed that in recurrent nerve paralysis during forced inspiration a spread of the stimulus from the inspiratory to the expiratory center causes closure of the glottis by the still unparalyzed cricothyroid muscle. It may cause a permanent spasm in bilateral recurrent nerve paralysis. As mentioned already, local anesthesia released in these cases the midline position of the vocal cords.

2. (Passive) Degenerative changes of joints and ligaments. This is repeatedly mentioned and was noticed by Grossmann [5]: "The position of the vocal cords in cases of recurrent nerve paralysis of long duration is also influenced by changes in the cricoarytenoid articulation occurring in the course of time."

Almost identical statements were made by Kuttner,[36] Burger,[3] and others. Neumayer [5] considered ankylosis as responsible for failure in the cutting of the recurrent nerve, as in Ruault's case.

Jeschek [37] calls attention to arthrosis, which may occur after median position of long duration. He recommends examination of the mobility of the joint by the probe test before doing a neurotomy. Messerklinger and Propst [38] proved histologically the presence of pathological changes in the joint. They found narrowing of the intra-articular gap, adhesions, and degeneration of the synovial membrane.

Obviously ankylosis inactivates all muscles operating directly or indirectly through the articulation. The only muscle unaffected in recurrent nerve paralysis, the cricothyroid muscle, undergoes atrophy by disuse. This was seen by Türck,[5] Grossmann,[5] Neumayer,[35] and others.

I have seen it in a case of bilateral midline fixation where I considered a procedure which represents a thyrocricoid myoplasty. It occurred to me that transposition of the cricothyroid muscle by separating it from its upper attachment and suturing it to the upper tracheal ring could probably reverse the action of this muscle, changing it from an adductor to an abductor. However, when the opportunity for a trial presented itself in a case of bilateral midline fixation of long duration, there was no cricothyroid muscle present. All we saw were a few pink fibers visible through a thin fascia. Removal of this tissue did not change the position of the vocal cords.

Answer to the Question Concerning Factors Responsible for Success and Failures in Therapeutic Cricothyroid Elimination

The rationale of therapeutic cricothyroid elimination is to abolish the tension produced by this muscle, thus changing the midline position into the cadaveric. Prerequirements for such a result are (1) condition of joint and elastic structures such as to permit the lateral shift and (2) the presence of a functioning cricothyroid muscle. Nothing can be achieved by paralyzing or removing a nonfunctioning muscle. These prerequisites are regularly present in the experiment when the cricothyroid elimination follows the recurrent nerve division after a short interval. They may be absent, however, in the clinical case, when the patient presents himself as a rule when arthrosis and muscle atrophy has already developed following a considerable period of time.

Prognostic Tests of Therapeutic Cricoarytenoid Elimination

A. Cocainization of the larynx when followed by relief of midline fixation might present a favorable prognosis for cricothyroid elimination by which the efferent limb of the reflex arc is interrupted.

B. Probe test for joint condition. This test was first described by Kühne [39] following a suggestion of Körner in 1908. Jackson deserves credit for its popularization. It is

known by the descriptive name "passive mobility test." It was frequently used in these cases, but its reliability is questioned, since movements of the soft tissue may simulate articular mobility.

C. In my opinion, a third test, so far not yet used, deserves a trial. It may be called "the probatory cricothyroid elimination." One per cent procaine injected into the cricothyroid muscle should provide release and widening of the glottis if tonus of this muscle is responsible in any way for the midline fixation in the individual case.

Some Peculiar Findings Noticed Subsequent to Arytenoidectomy

There is reason to assume that sometimes a lateropexy is performed in cases of midline fixation where cricothyroid elimination could have been a satisfactory procedure. This suspicion is based on two recently observed cases. In both arytenoidectomy was performed for relief of "bilateral abductor paralysis." In one the tracheotomy dated back 12 years, in the other for 3 months. In both we noticed a few months after the arytenoidectomy free movement of the opposite vocal cord extending about 3 mm. lateral from the midline. This observation indicated that in these cases a reflex stenosis was present resembling a bilateral midline fixation. Probably, it could have been unmasked by cocainization and probatory cricothyroid elimination. In all probability a favorable result would have been obtained by superior laryngeal neurectomy or cricothyroid myectomy.

My observations are not the first of this kind. Kressner [18] mentions that he noticed in some cases remobilization of the opposite vocal cord subsequent to laterofixation. He refers to similar observations of others. Clerf [40] mentions movement toward the midline made by the vocal cord on the side opposite to the operation.

One can conceive that in cases such as the above a reflex contracture was imitating a bilateral midline fixation. It might be that in the future cases of this kind will be helped by a simple cricothyromyectomy or superior laryngeal neurectomy.

The present discussion is not presented as an answer to the numerous questions involved in the old recurrent nerve problem. Its purpose is (1) to provide information from the literature about success and failure experienced in the past with the technique at issue, (2) to consider factors possibly responsible for these different results, and (3) to suggest clinical tests probably indicative for the prognosis in the individual case.

Summary

1. Therapeutic cricothyroid elimination was done with various results in the past.

2. Factors probably responsible for success and failures are discussed on the basis of anatomical experiments and clinical studies in the literature.

3. The abductor muscle (cricoarytenoideus posticus) is not the opener of the glottis; it is its dilator.

4. Closure of the glottis and inability to open it in bilateral recurrent nerve paralysis does not depend on paralysis of the abductors, in other words: so-called "bilateral abductor paralysis" is not a bilateral paralysis of the abductors.

5. The glottis opens in the absence of any muscle action by release of the adductor tonus and liberation of the elastic forces of the conus elasticus.

6. Bilateral midline fixation may be caused by either one of two factors separately or in combination: (*a*) degenerative changes of joins and ligaments and (*b*) reflex contracture.

7. Midline fixation can be released by cricothyroid elimination (*a*) as long as degenerative changes are absent or are not too far advanced and (*b*) when caused by reflex contracture.

8. Tests which prognosticate the results of cricothyroid elimination depend on (*a*) passive mobility, (*b*) cocainization of larynx, and (*c*) probatory cricothyroid elimination.

9. These tests should be performed routinely before the method of therapeutic enlargement of the glottis is chosen.

Conclusions

From various factors considered in the present discussion it can be concluded that cricothyroid elimination cannot generally replace modern and more complex methods of arytenoidectomy and/or lateropexy but that this technique may be used advantageously when restricted to its own territory. This includes (A) cases of bilateral recurrent nerve paralysis of short duration where irreversible structural changes have not yet developed and (B) cases where an additional reflexly induced contracture of the cricothyroid muscle may be an integral factor.

On the basis of the preceding discussion and exposition, a fruitful revival of an old but long neglected procedure may be initiated.

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The Importance of the Mesial Crura in Nasal-Tip Reconstruction

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In the progressive development of modern rhinoplasty, advances in corrective surgery of the nasal tip have been highly important, based chiefly on modeling of the lateral crura. The significance of the mesial crura in repair of the nasal tip has not been emphasized. This paper discusses the anatomy and surgery of these structures to show how not only to attain but to maintain the tip in this new cephalic position without the aid of implants.

An undesirable "surgical" appearance is the unduly pointed nasal tip. This may be formed because of (1) imperfect trimming of the mesial crura, (2) type of reconstructive method which reassembles the elements already present and holds them in place by a columellar batten or strut, or (3) insertion of a cartilaginous button in the apex of the lobule for purposes of projection. The behavior of grafts is unpredictable; some cartilaginous or bony struts or buttons may persist in an overcorrected position; some absorb or warp; some autogenous cartilaginous battens, especially in younger patients, may continue to grow, and consequently the tip becomes unduly pointed.

One must sympathize with the operator who has obtained the above results. In reconstruction a surgeon endeavors to form a nasal tip which will not ultimately droop. He is aware that the nasal tip will be transiently stable and esthetically satisfactory for two to four weeks before the droop becomes obvious. To avoid this undesirable effect, surgeons have resorted to the use of various sutures and techniques of suturing between the septum and columella, to overcorrection, and to use of battens and buttons and prolonged adhesive tap dressing. Generally, incorrect treatment of the mesial crura produces the "drooping." If these are incompletely freed and merely cut at their angles, or if the tip is corrected without marginal incisions, the tendency toward drooping is increased. Important steps in obtaining and sustaining a natural-appearing tip include the surgical approach, modeling, reattachment of the mesial crura to each other and to the correctly shaped septum.

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Anatomical Considerations

For a clear understanding of the nasal-tip problem a review of the surgical anatomy of the lower lateral cartilages is desirable. These structures form the major part of the lower cartilaginous vault; they maintain nostril patency by encircling and sustaining the margins. Each cartilage is composed of a lateral and mesial crus. The crura are in continuity, each forming a rounded angle at the nasal apex.

The lower lateral cartilages form a U-shaped arch but do not lie on an even plane. The mesial crus is at a lower level than the lateral crus, which is oval and has an aponeurotic attachment by its upper border to the upper lateral cartilage. The upper margin of the lower lateral cartilages overlaps the upper lateral cartilages, and the connecting intercartilaginous aponeuroses form two intravestibular "troughs," the limen vestibuli. Anteriorly, the lateral crura blend at the angles, and posteriorly, the margins are embedded in dense fibrous connective tissue attached to the maxilla.

The two mesial crura are contiguous and connected superiorly to the septal cartilages by the membranous septum. Anteriorly, the crura continue into the angles with their posterior ends extending nearly the length of the columella. Usually they curve slightly lateralward, ending in rounded extremities, but occasionally they are completely straight.

The angles of the lower lateral cartilages are arched and to a great extent determine the contour of the tip. The degree to which the angle is shaped—mesial crus and lateral crus—influences the final appearance of the nasal tip. At the nasal apex the lower lateral cartilages are separated by a notch and are united by connective tissue. The septum lies above and posterior to the angles, being attached thereto by connective tissue. Each angle blends with the lateral crus and the mesial crus, and the vertex of the angle divides into a lateral and a mesial part.

The lower margins of the lower lateral cartilages do not extend to the free nostril edges, which, devoid of cartilage, are composed of fat, connective tissue, and skin.

The lesser alar cartilages are small, of variable number, and embedded in the fibrous tissue and wings of the nose, between the lateral crura of the lower lateral cartilages and the maxilla. There are usually one to three sesamoid cartilages placed between the upper and lower lateral cartilages.

From the viewpoint of reconstruction of the nasal tip, the anatomy and physiology of the mesial crura have not generally been given the wide study required. The belief that the posterior ends of the mesial crura extend about halfway in the columella has not been substantiated by our surgical and necropsy experience. Careful dissection of the mesial crura has disclosed that although the posterior margins curve laterally they extend the columellar length. This is often an advantage; our first low hemitransfixion incision and intercolumellar suture bring the posterior crural margins together. This forms an improved nasolabial angle and gives the added crural rigidity often necessary because, as a rule, the part is flaccid in the area. After complete transfixion, the columella rotates upward. The areas of insertion and emergence selected for the first suture determine the desired tilt of the nasal tip. In men its projection should be in conformity with the dorsum and in women slightly elevated above the profile line. As stated above, the lateral crus is on a higher level than the mesial crus. Reversing this position forms a new angle which, when maintained, results in the desired tip projection. It is the formation of this new angle, in the manner to be described below, that retains the new dome and prevents secondary drooping. This is accomplished without the use of struts, battens, or buttons, except where indicated in specific deformities, for example, a short columella, recessed tip caused by abnormal brevity of the anteroposterior part of the mesial crura, or their backward displacement.

Operative Techniques

A small vertical incision is made in the lower quarter of the columella, and the base of the columella is freely undermined. Subcutaneous intercolumellar tissue is removed. A mattress suture of No. 000 chromic absorbable (gut) surgical suture material is passed through the columella to the opposite side and is returned to the area of entry. Another strand of No. 000 chromic absorbable surgical suture material is inserted through the loop in the contralateral side of the columella, and both sutures are tied. The ends of the sutures are left long enough to reach the chin, where they are grasped by an artery clamp.

The soft structures over the bony and upper cartilaginous vaults are elevated, and the nose is transfixed. The intercolumellar sutures are cut about ¼ in. beyond the knots. The caudal margin of the septum is removed for the required shortening but left absolutely straight. The mucosa of the septum is then deepithelized. The two septocolumellar sutures are inserted and tied before freeing the tip, since the complete separation of the tip leaves it loose and

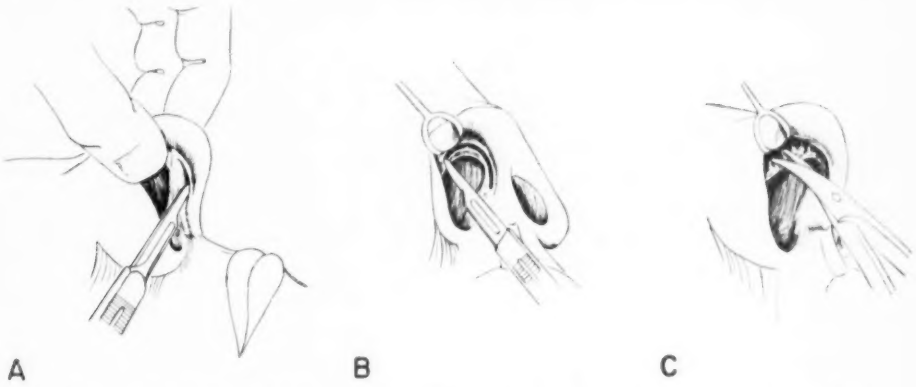

Fig. 1.—Exposure of lower lateral cartilage: *A*, mesial marginal incision; *B*, marginal incision extended laterally; *C*, Joseph scissors inserted through incision separating cartilages from overlying tissue.

flaccid. The posterior half of the mesial crura having been adjusted and affixed to the septum, the upper part requires trimming and fixation to the septum.

Circumferential incisions are made within the lower margins of the nostrils, extending caudally and downward and including the posterior part of the columella for about one-quarter of its length. The overlying soft tissues of the entire tip are separated, including the lobule (Fig. 1*A*, *B*, and *C*). The cartilages are exposed and the angles cut in such a manner that part of the mesial-cephalic margin of the lateral crura is incorporated (Fig. 2*A*, *B*, and *C*). The mesial crura are exposed, their intervening connective tissue removed, and the crura approximated by a through-and-through No. 000 chromic absorbable surgical suture threaded through two straight needles. If contiguity has not been obtained, a supplementary No. 000 chromic absorbable surgical suture is inserted. The ventral margins of the crura are trimmed, depending on the desired projection of the tip. The final step consists in angulating the ventral margin of the mesial crura so that the caudal margin remains higher than the cephalic; the mesial crura are thus not in direct line with the profile but tilt and rotate upward. When the desired tip projection has been formed a third septocolumellar suture of No. 000 chromic absorbable surgical suture material is passed high in the septum and through the columella and tied. This produces a firm columella and properly placed mesial crura (Fig. 3*A*, *B*, and *C*).

The lateral crura are fashioned according to the surgeon's customary technique. I prefer to remove a small strip of cartilage,

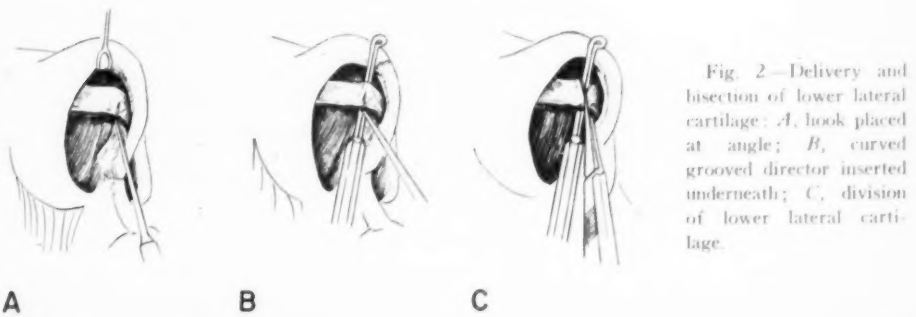

Fig. 2.—Delivery and bisection of lower lateral cartilage: *A*, hook placed at angle; *B*, curved grooved director inserted underneath; *C*, division of lower lateral cartilage.

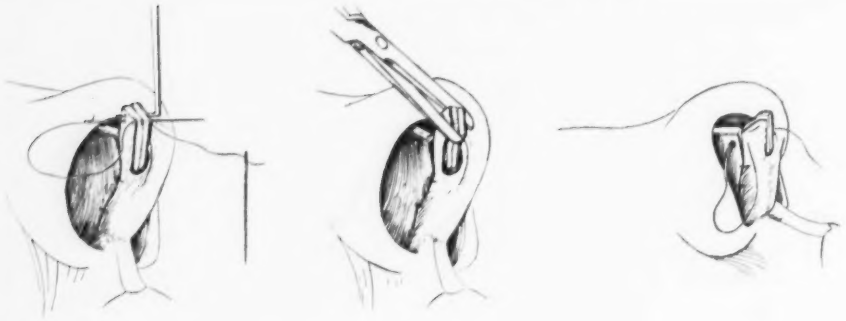

Fig. 3.—Reattachment and shaping of mesial crura: *A*, mesial crura brought together with suture threaded through two straight needles (note two septocolumellar sutures which have previously been inserted). *B*, trimming mesial crura at an angle (note straight caudal margin of septum). *C*, third suture placed high approximating mesial crura to septum.

without skin, from the previous residual angle; this is equivalent to the mesial-cephalic margin. An L-shaped incision is then made. This produces a narrow tip which will not heal with a postoperative "pinched" surgical appearance.

The nose is then packed with petrolatum gauze. A narrow strip of adhesive tape ¼ in. wide is placed across the base of the lobule and over the sides of the nares and is secured by a horizontal strip placed across the nasal dorsum directly above the tip. This also immobilizes the mesial crura. A wedge-shaped hexagonal piece of adhesive tape is applied across the dorsum with its lower edge in line with the previously placed horizontal adhesive strip. The first strip is then adjusted with a vertical tuck by gently pinching it at the center with a small hemostat. The heaped adhesive tape is excised, and another strip of adhesive tape is placed across the underlying sectioned adhesive plaster (Fig. 4*A* and *B*).

Because the loose skin readily conforms to the altered shape of the cartilages, the dressing and fixation of the cartilages must be carefully done. The structures heal in their new position. After four days the packing and dressing are removed, and the adhesive tape is reapplied for another four days.

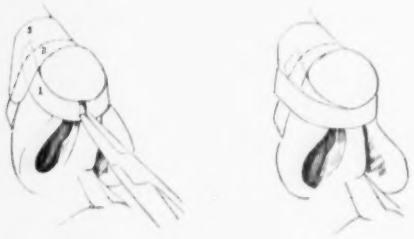

Fig. 4.—Position of remodeled mesial crura assured by careful external adhesive dressing and internal support with petrolatum gauze: *A*, strip of adhesive placed (1) caudal to lobule, (2) cephalic to mesial crura, (3) broad rectangular piece on dorsum. Immobilized tip structures made by gentle tightening of caudal strip of adhesive tape and removal of excess. *B*, separation of cut adhesive edges prevented by superimposing strip in front.

Conclusions

For liberation and delivery of the lower lateral cartilage, the marginal incision is necessary. It extends to and includes the upper part of the columella, thus permitting free exposure of the cartilages and lobule. The direction of the mesial crura is similarly followed by the lobule. The straight caudal margin of the septum prevents the cephalic margin from rotating cephalically. A curved caudal margin, which simulates the normal septal curve, causes the mesial crura to bow

caudally. This is the reason for the use of a batten or button to fill the area which otherwise would be rounded and, in some cases, flattened. The straight caudal margin of the septum, after being incorporated with the mesial crura by septocolumeller sutures, acts as a batten.

The mesial crura treated in the manner described manifest unusual firmness required in contouring the nasal tip. The need for implants is greatly diminished. The appearance of the tip is esthetically better than when battens or buttons are inserted. Malformation caused by inadequate mesial crura requires the use of implants for bolstering.

Summary

A technique is described for corrective surgery of the nasal tip which, as a rule, obviates columellar implants. Advantage is taken of the architecture of the mesial crura and the caudal margin of the septum for purposes of creating an esthetic tip which will not have an unnatural appearance. In addition, the undesirable postoperative changes are avoided by altering the relative anatomical positions of the mesial and lateral crura, which upon healing maintain the desired tip angle.

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Laryngocele

Report of a Bilateral Case

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The purpose of this paper on laryngocele is twofold. First, it is my desire to call your attention to a rare swelling of the neck that presents no great difficulty in diagnosis if one keeps it in mind. Secondly, I wish to add a case to the list of less than a hundred reported laryngoceles in the literature, of which very few were bilateral.[8] Only 14 cases of laryngocele were reported in a 10-year period.[1]

A laryngocele is defined as a cystic dilatation of the saccule or laryngeal appendix of the ventricle of Morgagni, and, depending on the extent of its development, it may be classified as internal, external, or combined.[1,5,6] An internal laryngocele is one that is internal to the thyrohyoid membrane, while the external type has herniated through the membrane into the superficial tissues of the neck. It is doubtful if the internal portion of the sac can avoid dilatation in an external laryngocele, therefore most so-called external laryngoceles may be considered to be combined. Forced respiratory effort of any type (coughing, nose blowing, forceful talking) may cause enlargement or inflation of the cyst. It may usually be emptied by pressure on the sac.

Historically, Larrey,[3] a surgeon in Napoleon's army, wrote in 1829 about air-filled tumors in the necks of men who called the people to prayer in Egypt. Virchow in 1867 reported a case and first used the term laryngocele. Much of our present knowledge is due to careful dissections of the saccule by anatomists before laryngoceles were described (Morgangi [1741], J. Hilton [1837], and, later, Von Hippel [1910]).

Our conception of laryngocele presupposes the presence of a well-developed saccule lined with ciliated columnar epithelium with 60 to 70 mucus-secreting glands. The mucus from these glands empties into the anterior portion of the ventricle and helps lubricate the vocal cords. There are lymphoid follicles in the submucosal tissues of the saccule. A laryngocele forms when either excessive endolaryngeal pressure or obstruction to the exit of air causes a dilatation of the saccule. This accounts for the greater frequency of the condition in those who subject their larynges to constant or repeated increases of air pressure (loud speakers, horn blowers, etc.). Laryngeal cancers[10, 11] and other growths have been reported associated with laryngocele, perhaps causing them by obstructing the outflow of air from a saccule. There are some investigators (von Hippel) who feel that in a true congenital laryngocele none of these factors are essential.

Symptomatology

The symptoms produced by laryngoceles depend on the extent of development and on the location of the dilatation (type). An internal laryngocele may vary from one barely discernible and producing no symptoms to one large enough to cause voice changes (hoarseness) and respiratory obstruction.[5,6] A strictly external laryngocele will produce neither of these but will present a swelling in the neck located below the hyoid bone, medial to the sternocleidomastoid muscle, and deep to the skin, superficial fascia, and platysma muscle. The mass en-

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larges when the intraglottic air pressure is increased and can usually be emptied by external pressure, sometimes with the sound of air escaping within the larynx. Unless infection has taken place pain is not a factor.[12] A combined laryngocele will have some combination of the symptoms described for the internal and external varieties.

Diagnosis

Diagnosis of an external laryngocele is usually fairly simple.[13] A sac in the location noted which expands when intraglottic pressure is raised and can be reduced by external pressure is almost sure to be a laryngocele. Confirmation can be made by aspiration of air and by x-ray studies (Figs. 1 and 2).

Fig. 1.—Radiograph showing air-filled sacs preoperatively.

Fig. 2.—Radiograph in another position before operation.

Occasionally at aspiration mucoid or purulent material is obtained, and this may tend to confuse the diagnosis.[6,12] Internal laryngoceles are not quite as easy to diagnose. A swelling of the ventricle generally or of a localized area in the aryepiglottic fold can frequently be palpated with a probe or with the end of the laryngoscope. The fluctuant character of an air-filled cyst or emptying of the sac with reduction in size suggests laryngocele. It is most frequently confused with a true prolapse of the ventricle, a condition which results from inflammatory edema or hypertrophy with bulging of the ventricle into the lumen of the larynx.[4,7]

Treatment

The treatment of laryngocele is the surgical removal of the cyst or cysts if symptoms justify it. Attempting to remove it by cauterization or through a laryngoscope is to be condemned, as is x-ray therapy. The external type is approached through a horizontal incision over a prominent portion of the sac, usually just below the hyoid bone. The incision is from the medial border of the sternomastoid muscle across the midline and, if one chooses to remove bilateral laryngoceles at one operation, it is carried across to the other sternomastoid. The cyst is carefully dissected medially, under the ribbon muscles and through the thyrohyoid membrane, over the superior border of the thyroid cartilage, and it is amputated after ligature as close to the ventricle as is possible. In some cases partial removal of the hyoid bone has been necessary.

Internal laryngoceles are removed generally by an approach through a lateral thyrotomy.[9] Jackson [10] points out that a thorough study should be made prior to operation to rule out the presence of lesions that might be causing obstruction (papilloma, cancer, etc.).

Report of a Case of Multiple Laryngoceles

A 28-year-old white man, a circus barker, was admitted to the hospital on Nov. 23, 1954, complaining of progressive hoarseness of two years' duration. His voice was very deep, and it was difficult for him to speak loudly or clearly. He had noticed a swelling on each side of the neck which would come and go. This swelling was more pronounced on the left. He experienced some difficulty in swallowing solid food.

Fig. 3.—Masses enlarged when intraglottic air pressure was increased.

Examination revealed a large, soft, compressible mass in the left side of the neck medial to the sternomastoid muscle at about the level of the hyoid bone. A smaller mass with similar characteristics was found on the right. Both masses enlarged when patient increased his intraglottic air pressure and were compressible by outside pressure (Figs. 3 and 4). Mirror laryngoscopy

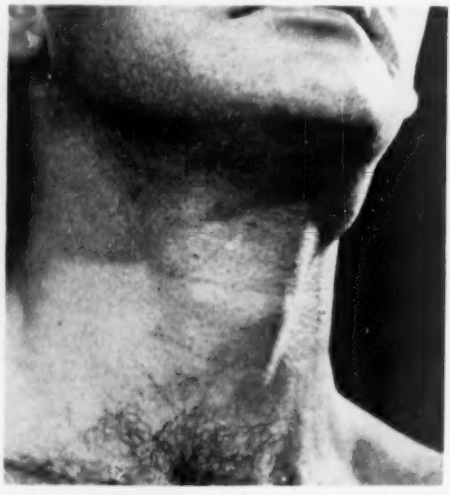

Fig. 4.—The larger swelling is noted on the left side of the neck.

revealed a generalized swelling of both ventricles to a point where it was barely possible to see the true vocal cords. The cords moved but the voice was hoarse. X-ray examination confirmed a diagnosis of bilateral laryngoceles with double or loculated sacs on each side.

Treatment was surgical removal of sacs, and it was decided to do one side at a time to lessen edema and the possible need for tracheotomy. On Dec. 10, 1954, the right side was operated on using the technique described above. This sac was constricted at its middle by a band of fibrous tissue (Fig. 5). On Jan. 31, 1955, the right side was done; however, two cysts were found (Fig. 6), each connected by its own stalk to the right laryngeal ventricle. It was not necessary to disturb the hyoid bone or the thyroid cartilage in this case.

Postoperatively, the voice and laryngeal appearance returned to normal and have remained so until the present time (15 months later) (Fig. 7).

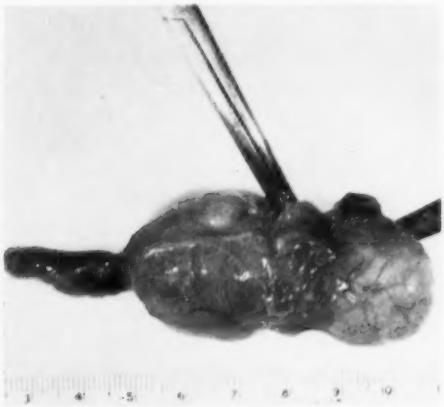

Fig. 5.—Larger sac from left side constricted at its middle by fibrous band.

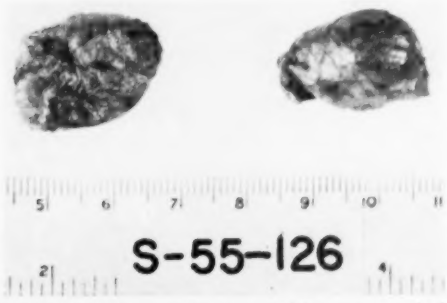

Fig. 6.—Two smaller sacs which were attached separately to the right laryngeal ventricle.

Fig. 7.—Postoperative appearance of patient; swelling no longer present.

Summary

Attention is called to laryngocele as a possible cause of swelling in the neck.

History, origin, symptomatology, diagnosis, and treatment are briefly discussed.

A case of bilateral and multiple (right side) laryngoceles is reported.

Dr. David Farwell, Department of Otolaryngology; Dr. C. P. Oderr and Dr. James Shaw, Department of Radiology, and Mr. William D. Bohon and Mr. Thomas C. Morris, Department of Medical Illustration, V. A. Hospital, New Orleans, contributed in the presentation of this case.

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Clinical Evaluation of Food Sensitization in Perennial Nasal Allergy

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The otorhinolaryngologist who treats patients with ear, nose, and throat manifestations of allergy is frequently envied by his colleagues in allied fields of allergy, presumably because the type of patients that he sees are relatively simple to diagnose and treat. This viewpoint is based on the assumption that the etiology is primarily due to inhalant factors which are easy to detect and which cause symptoms that respond readily to treatment. The patient, as a rule, is not considered too ill; consequently, he is not expected to present a complicated clinical problem. As our personal experience in the knowledge and practice of handling the allergic patient increases, we are more impressed with the complicated problems presented to the otorhinolaryngologist who treats such patients. We have not found the diagnosis of perennial nasal allergy and its associated symptoms to be easy, nor is the treatment stereotyped and simple. The patients we see are not acutely ill as a rule, yet, it is the chronicity of the clinical syndrome which they present that makes treatment difficult. Likewise, since the patients with ear, nose, and throat complaints of allergic origin are not too sick in the sense of disability or discomfort, they are less prone to cooperate in a course of treatment which requires alterations in their way of living. This we found to be particularly true in the adult male with food allergies.

In one respect the otorhinolaryngologist who treats manifestations of allergy as they occur within the sphere of his specialty should be justifiably envied, for he is in a position to practice the purest form of medicine, namely, preventive medicine. It has been repeatedly proved and literature provides ample evidence that many of the disorders of the ear, nose, and throat are the late sequelae of complications which could have been avoided had their allergic background been recognized. Derlacki has shown this in the aural complications of allergy.[1] Yet, this privileged position which the otorhinolaryngologist holds places upon him a heavy burden of responsibility. He must practice the best type of allergy possible in order to prevent these complications which might result in disabling irreversible changes in the tissues affected.

In a critical evaluation of our own practice, we studied a group of patients who showed some improvement in their symptoms but failed to attain a degree of relief satisfactory to themselves or to us. While their symptoms improved under adequate inhalant desensitization therapy, they still continued to have nasal stuffiness, recurrent sore throats, and acute exacerbations of symptoms unrelated to environmental factors traceable to inhalants and showed little seasonal variations in their symptomatology. The obvious answer to the lack of improvement in this group of patients was inadequate treatment. In reviewing our therapeutic regimen it became evident that the weakness lay in our method of handling food sensitivities to which our patients were reacting.

Our method of handling food problems consisted of a routine set of intradermal tests to foods commonly ingested by people living in the area. A brief history was

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taken of the patient's likes and dislikes to certain foods with an attempt to correlate these with the skin-test findings. No attempt was made to instruct the patients as to the sources of the offending food and how they could be avoided. No ingestion tests were made. In our handling of the food-sensitive patient, we had sidestepped a difficult problem by assuming that food sensitivity was a minor factor in the causation of symptoms referable to the nose, throat, and ears due to allergy. We subsequently learned that such an attitude was an erroneous one.

Adjusting our practice to handle food sensitive-patients adequately was not an easy task. Six months elapsed before we were sufficiently staffed with personnel, had the proper office set up, and felt prepared to handle food problems adequately. The multiplicity of diagnostic techniques for specific food allergen diagnosis was confusing. We came to the conclusion that it was best to become well versed in one method and to adhere to that method. We therefore adopted the individual feeding tests of Rinkel and associates[2] with modifications as advocated by Derlacki.[3] Skin tests were not discarded, for we felt that they still served a useful purpose in screening out certain foods.

Many problems arose which had to be solved. Primarily they resolved themselves into the time involved, personnel, and adequate office space required. How can the busy otorhinolaryngologist find time to devote to food problems? We evolved a team concept, which has worked very well in the solution of our problem. The team consists of the following: The clinician at all times remains the directing force and supervises and oversees all the activities of the other members on the team. A nurse well versed in the skin-testing technique does the skin tests. A laboratory technician, personally trained by the clinician to evaluate the symptoms caused by food sensitivities, is entrusted with the food-ingestion tests, which are done with groups of four patients both for facility in testing and for the psychological effect upon the patients. Finally, an innovation in the team concept of the problem was the hiring on a part-time basis of a dietitian, who goes into details of the diets with the patients. It is again stressed that the patient is impressed with the fact that the clinician is in control and supervises all phases of the team's activities. By such a properly integrated team effort, the clinician can do an effective job of controlling his patients' food allergies without jeopardizing the patient-doctor relationship and at the same time he is able to delegate work to trusted associates who are aware of the role they play in making the patient well.

Careful selection of the personnel for this team is essential. They must be reliable, well trained, and imbued with a sincere interest in the problem of food allergy. The dietitian on our team concurs with us in the opinion that food-sensitivity problems should be stressed more in training dietitians and in the dietetic departments of hospitals. We have found that the dietitian is an invaluable aid to us in handling patients with food allergies.

Adequate space is a necessity in the development of this program. We advocate that food-ingestion tests be performed in a room not less than 10 by 10 or an average area of 100 sq. ft., well lighted, well ventilated, and located away from distracting noise and activities of a busy office.

In order to make a clinical evaluation of the effect that food sensitivity may have upon perennial nasal allergy and its associated symptoms, a study was made upon a group of patients who had persistent symptoms not relieved by adequate inhalant therapy. This group consisted of patients who were inadequately treated for their food allergies. They were private patients who had been under our personal observation for periods ranging from 3 months to 15 years prior to our revised method of handling food problems. We were intimately acquainted with their symptomatology and had personally observed their responses to therapy based on our team concept of handling food-sensitivity problems.

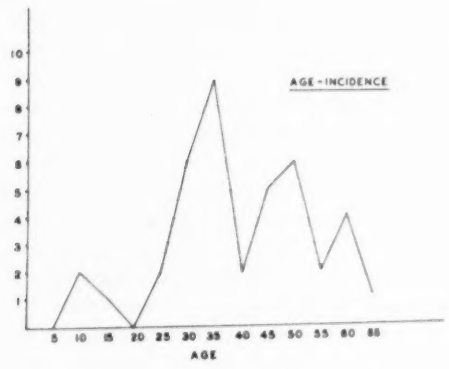

Figure 1

Age Incidence

The age incidence emphasizes two factors (Fig. 1): (1) Sensitivity to foods is not confined to the younger age group as the experience of some authors would indicate.[4] Our findings may differ because the age groups represented in our practice might be more varied. (2) We note a trend for persons in the older age group to come to our office with symptoms referable to all forms of allergy. At first we found ourselves temporizing with these patients and treated them with local therapy and antihistaminics because we felt they were too old to undergo any prolonged form of treatment. They no more responded to such a regimen than would any other age group. The physician practicing allergy will be called upon to care for such persons in increasing numbers. They have as much right to expect adequate treatment as does the younger age group. As Rusk points out, these persons are our responsibility.[5] Medical science has made the chief contribution toward mankind's increased longevity and should therefore endeavor to make these latter years pleasant and enjoyable.

Sex Incidence

The sex incidence in this series was as follows: males, 13; females, 27.

Females outnumbered males 2 to 1. The reasons for this are definite. Women are more patient than men and are more prone to adhere to one form of treatment, whereas men want to see results quickly. As a rule men cooperate less than do women, especially in such a taxing procedure as adhering to an elimination diet. Such factors as eating away from home, dependence upon others for preparing meals, and a need for increased caloric intake entered the problem.

Signs and Symptoms

Our clinical study is based on the persistence of signs and symptoms of allergic reactions in the nose, throat, and ears in spite of adequate inhalant desensitization therapy and the alleviation of these symptoms and clinical improvement observed in the patients following adequate management of their food sensitivities. The signs and symptoms presented are listed in Figure 2.

All the patients in this series had nasal symptoms consisting of obstruction to breathing, excessive production of secretions, itching associated with an excoriation of the nares, and, at times, dryness of the nose. Itching, sneezing, and increase in nasal secretions frequently occurred in the morning, suggesting reaction to foods ingested the previous day. The appearance of the nose varied, but as a rule the mucous membrane was pale, boggy, edematous, with a tenacious mucus discharge on the floor. Cytologic studies showed the presence of eosinophils in a high percentage of cases.

The oropharyngeal signs and symptoms primarily manifested by frequent sore

SIGNS & SYMPTOMS

NASAL SYMPTOMS	40
PHARYNGEAL & LARYNGEAL	
SORE THROATS	23
POST NASAL DRAINAGE	20
HOARSENESS	4
FREQUENT COLDS	16
HEADACHES	7
NASAL POLYPI	6
AURAL SYMPTOMS	
CATARRHAL OTITIS	5
OTITIS MEDIA	3
OTITIS EXTERNA	3

Figure 2

throats and persistent postnasal drainage constituted the most significant findings in this group. The sore throats would come on suddenly and were characterized by a deep throbbing pain which would radiate along the sides of the throat downward to the hypopharyngeal region and externally to the posterior neck muscles and the occipital region. Tenderness could be elicited to pressure along the carotid sheath and the borders of the sternomastoid muscles. The outstanding feature was the absence of the usual inflammatory reaction commonly seen in infectious processes affecting the throat. Seldom was a temperature elevation present. The mucous membrane of the oropharynx and hypopharynx would be dull red in appearance, with hypertrophy of lymphoid tissue in the lateral band region and scattered patches of lymphoid hyperplasia over the entire pharyngeal wall. The soreness would leave abruptly as it came, seldom lasting more than 24 to 48 hours. Some patients complained of a dull constant ache which would only be relieved by some form of sedation. A lump sensation deep in the throat was a common symptom.

Frequently patients who complained of recurrent sore throats had an associated postnasal drainage, which was very annoying, particularly in the morning. Eating breakfast would at times increase the amount of mucus to such an extent that some patients omitted the morning meal entirely. The amount of mucus would gradually diminish as the day went on. Upon examination a heavy tenacious stringy film of mucus could be seen covering the posterior pharyngeal wall. The mucosa underneath would appear dry, and reflected light would create the illusion of a glary, glossy surface. A pick-up forceps had to be used to remove the strands of mucus for cytologic study because the suction tip was ineffective. Smears often showed eosinophils in clumps scattered throughout the specimen. Irrigations, gargles, swabs, and medicated troches gave only temporary relief. The patients likewise complained of feeling a mucus plug lodged behind the soft palate. The sensation was so annoying that at times we have seen throats scratched and bleeding from attempts made by the patient to dislodge the offending glue-like mass of inspissated mucus. A colleague of ours who practices in this area has likewise been impressed by similar oropharyngeal findings in his patients, which he attributes to food sensitivity.[6] A large percentage of his patients have been relieved following adequate management of their food sensitivities.

Hoarseness was a specific complaint of four patients who also had accompanying oropharyngeal symptoms. The voice would change sometimes within an hour or two after meals. The vocal cords in these patients were thickened and edematous and at times would be covered by an exudate which resembled the glary mucus present in the hypopharynx. The chronicity of the hoarseness prompted two of the patients to seek medical advice because of the fear of laryngeal cancer.

Frequent colds were complained of in 16 cases. In most instances the colds were not related to the occurrence of colds in other members of the family nor were they transmitted to persons closely associated with the patient as one would expect in a true viral infection. Likewise, the colds would occur when epidemics of upper respiratory infections were not prevalent. The so-called colds would last varying periods of time, lasting from 24 hours to 5 days. In the latter instance the colds were accompanied by fever, malaise, and cough productive of frothy sputum. Some of the more astute patients in time learned to differentiate between a true cold and an allergic reaction. A chilling sensation coming on after meals was noted by some patients, who remarked that they were amazed not to have further symptoms other than the chilling. Rinkel has noted that a chilling sensation following the ingestion of certain foods occurs in many patients who are not major cases of thermal allergy.[7] We have found the sensation of chilling following the ingestion of foods to be a useful index of sensitivity when doing individual food tests.

Headaches were a prominent complaint in seven cases in this series. The headaches were characterized by a deep boring dull ache which was not relieved by the usual headache remedies, including ergot derivatives. The headaches varied in intensity and duration and came on without any prodromata. A feeling of fatigue frequently accompanied the headaches.

Nasal polypi were a persistent feature in four cases, three of which required removal twice even though the patients were treated adequately with inhalant therapy.

An interesting group of symptoms were referable to the ears. Recurrent attacks of catarrhal otitis media occurred in five cases. These would be associated with an exacerbation of the nasal symptoms. The membrana tympani would appear injected and the landmarks obscure. The ears would clear as the nasal symptoms subsided. Three cases of chronic otitis media were included in this group as were a similar number showing eczema of the external ear canals.

Treatment

We routinely place our patients on a food diary, for it gives us an idea of the eating habits of the individual patient and the relationship of their symptoms to food ingestion. Keeping a food diary likewise makes a patient food conscious and helps to orientate him in the problem of adjusting himself to a new dietary regimen. Specific instructions are then given to the patient as to what foods to avoid prior to each food-ingestion test. We have found that detailed diets are essential. It is not enough to tell the patient what he cannot eat in the period prior to a test; he must also be told what he can eat. A date is then assigned to the patient when he is to come for an individual food test. We attempt to do the tests in groups of four patients. This is done to facilitate the work of the technician doing the test. She can conveniently handle four cases at one time. One preprandial and three postprandial leukocyte counts are taken. Another reason for grouping the patients for the food tests is the effect observation of others has upon the individual patients. They learn what symptoms to look for, what reaction to expect from harmful foods and, what is of primary importance, they benefit from the experience of others. After the patients understood what was to be looked for in a food test, they were instructed to carry on further tests at home. With some patients we have found Derlacki's method[3] useful, particularly when we desired a rapid survey or if the patient had difficulty in working out a diet for himself as some did.

Once the basic studies are carried out, the patient is given a series of appointments with the dietitian, who then works with him on the details of the diet under supervision of the clinician, who determines what foods the patient is to avoid. The clinician also sees the patient at the end of the session with the dietitian to give him final instructions. Another innovation that we have evolved is to have group meetings of patients with the dietitian presiding to discuss common problems encountered in preparation of substitute foods. These sessions have proved invaluable both from the standpoint of improving the palatability of the substitute foods and to encourage patients to adhere to their diets. We have found the group approach to the problem a most potent factor in the management of the food-sensitive patient.

All the patients in the series were given individual food tests according to Rinkel's technique to wheat, corn, milk, and eggs in order to compare the results of skin tests with those of individual food tests by ingestion. Other food tests were done as indicated by the patient's food diary and clinical course. The results are illustrated in Figure 3.

Wheat and egg showed a surprisingly close relationship in the number of positive skin tests as compared with the positive reactions obtained by ingestion food tests. The results with egg and milk varied by about 50%. The difference between skin tests and

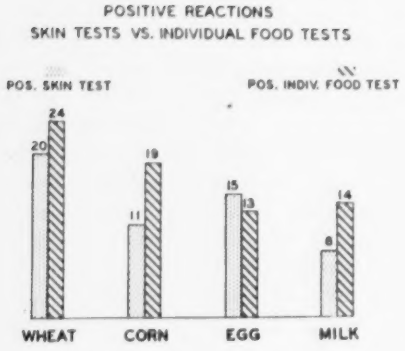

Figure 3

individual food tests to corn and milk is more in agreement with the findings of most authors who investigated this subject.

We have no explanation to offer for the discrepancy between the results of skin tests to foods and those obtained by individual food tests. Authors who have studied the problem in more detail are likewise at a loss for an explanation.[8]

Psychological Aspects of Treatment of the Food-Sensitive Patient

We have found Kaufman's observations upon the psychological aspects of handling the patient with food problems helpful in dealing with our patients.[9-11] In the treatment of the food-sensitive person the doctor-patient relationship is altered in that the patient becomes an active participant in the therapeutic program. He ceases to be a passive recipient of medication and advice designed to make him well; he must actively cooperate in a program which calls for altering a fundamental aspect of his life, namely, the food he eats. We were amazed at the obstacles encountered. Some patients refused outrightly to make any changes in their diets for reasons too numerous to mention. Others fell by the wayside and gradually reverted to their old habits of eating. We soon found that it was futile to adopt a dictatorial "do it my way or else" attitude. We had to be sympathetic, helpful, and encouraging. The dietitian on the team was of great assistance in this phase of the problem, for she helped the wives and mothers of the patients in making adjustments at home to the new routine. In the majority of cases the success or failure of the program depended upon the womenfolk involved, be they patients themselves or closely related to the patient. We insisted, therefore, that the wife or the mother of the patient attend the sessions with the dietitian together with the patient. We likewise took advantage of the beneficial psychological effect group sessions had upon the patients, as already mentioned.

Results of Treatment

The results following adequate treatment of food sensitivities in this series of 40 patients who had not responded satisfactorily to adequate inhalant therapy but whose food problems were improperly handled have convinced us of the importance of food as an etiologic factor in the causation of symptoms in perennial nasal allergy with associated manifestations of allergy in the throat and ears. We concur with Sheldon and associates that the physician should suspect food allergy, especially in patients having perennial unexplained allergic symptoms.[12] In evaluating the results we took into consideration the shortcomings of a clinical study which is dependent upon subjective responses from the patient as well as objective observations made by the clinician.

In an attempt to correlate the results of treatment with the cooperation of the pa-

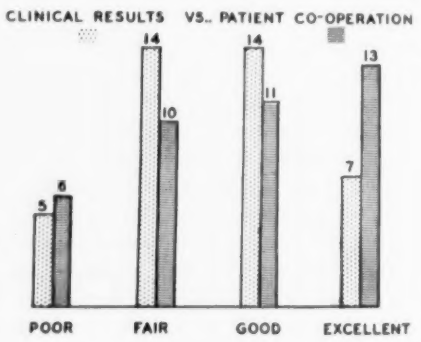

Figure 4

tient, we compared the cooperation of the patient as graded by members of the team with the clinical results as estimated by the clinician. The result is illustrated in Figure 4.

The table shows that the results obtained were for the most part directly related to the effort the patients put into adhering to the dietary regimen as outlined for them. The fact is obvious that the patient's cooperation is most essential. Yet even with poor cooperation one patient obtained fair results. The six patients whose cooperation was excellent yet whose results were classified as good probably represent a group whose food sensitivities were not completely worked out.

Nasal symptoms were relieved to a varying degree in 76% of the cases. Improvement was characterized by a decrease in drainage and the sensation of blockage was relieved. The usual morning reactions abated in the majority of cases. The nasal mucosa tended to be less congested, and the pale boggy turbinates assumed a more normal appearance. Nasal polypi showed a reduction in size in five of the six cases.

The most gratifying results were obtained in the group showing oropharyngeal manifestations. About 74% reported a reduction in the number of sore throats. The patients remarked about the relief they felt from the deep throbbing pain which had characterized the attacks. The reduction in the amount of postnasal drainage, particularly in the morning, was evident to even the most skeptic patient placed on the new dietary regimen. Upon observation it was noted that the mucosa had begun to assume a normal pink color with a noticeable decrease in the number of superficial blood vessels, which also showed less engorgement. The reduction in the amount of secretions was striking. Hoarseness, which had been present in four cases, became less noticeable in three.

There was a noticeable decrease in the number of so-called colds. This was more marked in the few children in the series. The colds that did occur showed more of the characteristics of a true cold now than the colds prior to treatment.

The most dramatic results were noted in the cases complaining of headaches. All seven noted relief of varying degree, depending on their adherence to the diets outlined for them. The case of a young married woman of 24 is worthy of mention. She had been suffering with headaches for years. Visits to three outstanding clinics gave no relief. Finally, "to cease being a burden to myself and my family," the patient attempted to end her life. Her psychiatrist could find no cause for her behavior except the severity of her headaches. During the milk-ingestion test the patient's headache became so violent that the test had to be discontinued, a sedative given, and the patient taken home. Since the elimination of milk the patient has had no recurrence of her severe headaches.

The aural symptoms improved in all 11 cases. With the improvement in nasal symptoms the patients with recurrent catarrhal otitis noticed a decrease in the number and severity of their attacks. Those with otitis externa reported that their ear canals itched less and crusting was reduced. Two of the cases with bilateral chronic otitis media obtained dry ears, while the third noted a decrease in the amount of secretion. The case of a young woman of 26 is worthy of mention. She had bilateral draining ears since early childhood. A radical mastoidectomy had been done on the left, but the

SIGNS & SYMPTOMS

	IMPROVED		UNIMPROVED	
	NO.	%	NO.	%
NASAL SYMPTOMS	32	76	8	24
PHARYNGEAL & LARYNGEAL				
SORE THROATS	17	74	6	26
POST NASAL DRAINAGE	15	75	5	25
HOARSENESS	3	75	1	25
FREQUENT COLDS	11	69	5	31
HEADACHES	7	100		
NASAL POLYPI	5	83	1	17
AURAL SYMPTOMS				
CATARRHAL OTITIS	5	100		
OTITIS MEDIA	3	100		
OTITIS EXTERNA	3	100		

Figure 5

cavity continued to drain. She had been referred by an astute otologist, who had recognized the true nature of her affliction. The ears had shown improvement under our old system of therapy, but they continued to drain. During the wheat-ingestion test the patient became ill, her nose became stuffy, and the ears felt full. That evening the patient reported that she had all the symptoms of a cold and an increase in the ear drainage. After eliminating wheat from the diet both ears have ceased to drain.

We realize that the validity of the clinical observations cited above is dependent upon the reproduction or accentuation of symptoms following deliberate ingestion of the offending food designed to recreate these symptoms. In this series of cases sufficient time has not elapsed to attempt to reproduce the symptoms by deliberate ingestion tests, for some of the cases have been under the new form of treatment less than six months. Furthermore, being private patients, their feelings on the matter have to be considered. The majority have been so pleased with the results obtained that they are reluctant to undergo experiments which in all probability would cause recurrence of their symptoms. We felt obliged to inform them that such experiments might do so. However, a careful study of relapses in about 60% of the cases in this series has shown that the exacerbations of symptoms could be directly related to inadvertent or deliberate ingestion of an offending food. We feel that this has occurred in a sufficient number of cases to make our observations valid.

Summary

A clinical evaluation had been made of 40 patients with perennial nasal allergy and associated manifestations of aural and pharyngeal allergy who had not responded satisfactorily to adequate inhalant therapy but whose food sensitivities had been improperly managed. The improvement noted in their physical findings and the alleviation of their symptoms provided convincing proof that the management of food sensitivities in patients with ear, nose, and throat manifestations of allergy is as important as the management of their inhalant sensitivities.

A team concept of handling food problems in a busy otorhinolaryngologic practice is presented. It has materially aided us in dealing with our food-allergic patients.

9119 Miles Ave. (5).

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Audiology Section

JOSEPH SATALOFF, ASSOCIATE EDITOR

The Effect of Ointment Prosthesis on Fenestrated Ears

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The fact that prosthetic devices applied within the ear often produce noticeable improvement in the hearing is well known. "Artificial drums,"[1] patches over perforations of the tympanic membrane,[2] and tamponades properly inserted into the middle-ear cavity[3,4] have all proved effective in selected cases. Substantial evidence has accumulated indicating that (in cases with large tympanic perforations, radical mastoid cavities, etc.) obstructing the pathway to the round window can increase acuity.[5,6] Guild noted that hearing seemed less impaired in the face of marked damage to middle-ear structures when the round-window niche was filled with scar tissue,[7] and Hughson[8] developed a surgical procedure for obstructing the round-window niche with transplanted fascia. Most recently, Kobrak has developed the technique of applying a bland ointment to the round-window niche in cases where there is conductive loss with extensive destruction of the drum membrane.[9,10] Kobrak's technique has the advantage of being a very simple and easily controlled prosthesis.

Rytzner studied the effect of blocking the round window at various stages in the fenestration operation.[11] The result was slightly poorer hearing with the fenestral field fully exposed but before the fenestra itself was produced. Blocking the round-window region with fluid produced even better acuity after fenestration than was achieved at the termination of surgery.

Both Juers[12] and Skoog[13] had demonstrated that appropriate obstruction of the fenestrated ear (fully healed) improved hearing noticeably. Hence, Rytzner also investigated the influence of blocking such ears (fully healed) with dry cotton, alcohol solution, and Aquaphor (an oxycholesterol-petrolatum ointment base).* All three procedures yielded gains which averaged 5 db. or better from 125 through 1000 cps, with minimal change for tones from 2000 cps upward. However, the alcohol and Aquaphor were the more effective.

As soon as Rytzner's findings became known, Shambaugh[14] began using Aquaphor with some of his postfenestration cases. The results were so satisfactory that he and his associates have made this procedure routine. They applied 0.5 cc. of ointment on the pars tensa of the tympanic membrane. Their technique has remained unchanged except for the fact that they have subsequently shifted to Hydrosorb ointment (a mixture of the oleic acid ester and amide of diethanolamine in petrolatum) so as to minimize the occasional irritations which result when the material is left on the tympanic membrane for several months.

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This study was supported by funds provided, under contract V 1001M-3614, by the Veterans Administration through the Prosthetic and Sensory Aids Service, Department of Medicine and Surgery. The study was performed under the auspices of the Department of Otolaryngology and the School of Speech, Northwestern University.

* Rytzner chose Aquaphor because Kobrak had found this material to be clinically superior as an ointment prosthesis.

Although Rytzner has given us a general indication of the mean gain to be expected from ointment prostheses and Shambaugh has demonstrated their clinical value, there has remained need for systematic exploration of the conditions wherein the acuity of the postfenestrated ear is favorably affected. Such an exploration was undertaken in the study we are reporting here. The basic procedure was to test the hearing of postfenestration cases by pure-tone audiometry both before and after four different applications of Hydrosorb in the ear operated on. The sequence of tests was repeated in a new order on a second visit. Tests by bone-conduction and air-conduction measures on the unfenestrated ear were also included,† the latter for the purpose of furnishing control data. The results were analyzed statistically to discover (1) the consistency of improvement yielded by Hydrosorb prosthesis, (2) the relative gains induced by different manners of placing the ointment, and (3) the relation between the acoustic success achieved by fenestration surgery and the added benefit derived from Hydrosorb.

Procedure

A total of 109 adults made the two visits necessary for the study. These cases were selected from the files of the otologists participating in the project.‡ All subjects had undergone fenestration surgery. The goal was to obtain a distribution representing varying degrees of postsurgical success. Therefore, the only criteria for selection observed were that each subject must (1) reside in the Chicago area, (2) have a healed and nonsuppurating endaural cavity, and (3) have undergone fenestration surgery at least four months prior to participating in our study.

It subsequently developed that only 93 cases yielded sets of data which were sufficiently complete to warrant detailed analysis. In terms of preoperative classification of surgical suitability for fenestration, these 93 subjects distributed themselves as follows: Class A, 60; Class B, 23, and Class C, 10 cases.

Pure-tone thresholds were obtained for both ears under a variety of conditions, as described later. The subject's fenestrated ear was the experimental ear. However, in the few cases where both ears had been fenestrated, the poorer ear was taken as the experimental ear. The other ear served as a control. Thresholds were measured at octave intervals from 125 through 8000 cps by air conduction and from 250 through 4000 cps by bone conduction. A standardized masking procedure was employed during bone-conduction audiometry.

All hearing tests were administered with a Sonotone audiometer, Model 22, equipped with thermal noise as its masking sound. The physical performance of the air-conduction system was measured with an artificial ear assemblage (NBS 9A coupler and W. E. 640AA microphone). The instrument proved to have acoustic outputs conforming to the NBS norm within the limits specified by the ASA standards.[15] The bone-conduction system was calibrated clinically according to the method discussed by Roach and Carhart.[16] Appropriate rechecks of the audiometer's performance were made periodically.

The auditory examinations were conducted in an audiometry room within the private offices maintained by the otologists who participated in the study. This room has an ambient noise level of 37 db. (*A* scale reading on a General Radio 760 Sound Level Meter).

Turning now to details of procedure, each subject was seen for two sessions of three hours each. At least two weeks elapsed between the two visits. Each visit began with an otoscopic examination, at which

† Differential sensitivity to intensity change was also measured, but the results are not being reported in this paper.

‡ The participating otologists were George E. Shambaugh Jr., M.D., Eugene L. Derlacki, M.D., and Wiley H. Harrison, M.D. Audiometric testing and some of the subsequent analyses of data were performed by Janet Jeffers, Ph.D., and Marjorie Adamson.

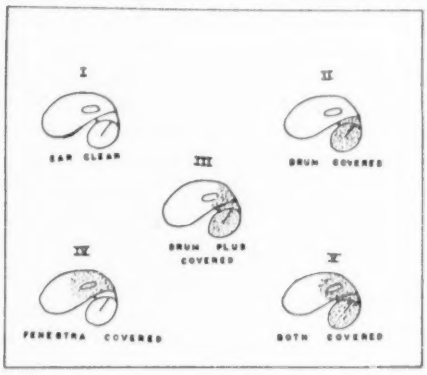

Fig. 1.—Schematic representation of the medial wall of the right endaural cavity showing the positions in which Hydrosorb was applied.

time the ear was cleaned if necessary (Condition I). The otologist then applied ointment prosthesis (Hydrosorb) as required by the experimental design. He made appropriate changes in the placement of the Hydrosorb as the session progressed.

Hydrosorb was placed only in the experimental ear. Four positionings of Hydrosorb were employed. These are illustrated in Figure 1 and were as follows: Condition II, approximately 0.4 cc. applied so as to cover the entire tympanic membrane; Condition III, a little more than 0.4 cc. applied so as to cover the entire drum and project upward on the medial wall of the endaural cavity but to leave the new fenestra exposed; Condition IV, about 0.6 cc. applied so as to cover the new fenestra but to leave the drum membrane exposed; Condition V, approximately 1.0 cc. applied so as to cover, in their entirety, both the new fenestra and the eardrum.

The five conditions were produced in the order which proved most practical to the otologists. The first visit began, as already mentioned, with an otoscopic examination and a cleaning of the ears. Puretone thresholds were next obtained for the experimental ear, and also for the control ear, by both air and bone conduction. Hydrosorb was then applied by syringe so as to yield Condition II. The full series of hearing tests just described was repeated. Sufficient ointment to give Condition V was next added, and thresholds for both ears were measured by air conduction only. Enough Hydrosorb was now removed so as to achieve Condition IV, and the acuity of the experimental ear for both air and bone conduction was determined. Finally, the otologist removed all Hydrosorb and reapplied enough to give Condition III, after which an air-conduction test was administered to each ear. The patient was dismissed without disturbing the final placement of the ointment.

The first procedure during the second visit was to obtain a complete set of thresholds (Condition III). The fenestrated ear was then cleaned (Condition I), and the full test sequence was repeated.§ Hydrosorb was then applied to the new fenestra (Condition IV), after which air- and bone-conduction responses were measured only through the experimental ear. Subsequently, enough ointment was added to cover the tympanic membrane also (Condition V). The air-conduction acuity of both ears was then determined. Thereafter, the fenestra was exposed, leaving Condition III. The final step was to obtain both air- and bone-conduction audiograms for the experimental ear.

The data gathered through the foregoing procedures were treated statistically to ascertain the influence of Hydrosorb placement on acuity for air-borne stimuli and on the thresholds for hearing by bone conduction. Auxiliary analyses were undertaken to explore the test-retest reliability of selected measures on the experimental ear and to determine the stability of the methodology as revealed by the behavior of the control ear. The main finds are summarized below.

Influence of Hydrosorb Placement on Air-Conduction Thresholds

Figure 2 summarizes, in audiometric form, the mean acuity prior to application

§ Differential sensitivity to intensity change was also explored at this point.

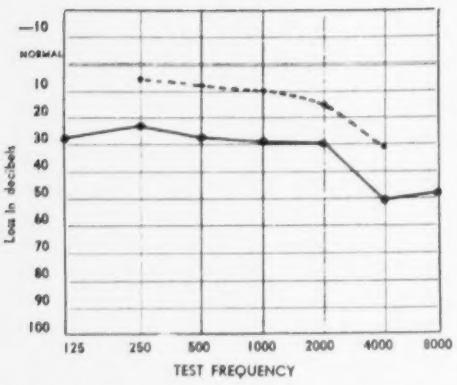

Fig. 2.—The mean audiogram, for 93 fenestrated ears, obtained during the first visit but prior to application of Hydrosorb.

of Hydrosorb for the 93 fenestrated ears given full analysis in this study. The same information is presented in more detail by Table 1, which gives not only the averages for the entire group but also the separate means (averages) for each category of surgical suitability. Table 1 also includes the corresponding standard deviations, each of which represents the span on either side of the mean needed to encompass about two-thirds of the scores. These data constitute the base of reference for evaluating the benefits yielded by the other experimental conditions.

The averages of the air-conduction thresholds obtained during the first session under the four conditions of Hydrosorb placement, plus details by surgical types and variability as evidenced by standard deviations, are reported in Table 2. Two facts immediately are evident by comparison with the findings shown in Figure 2 and Table 1. First, acuity was mildly improved by the application of Hydrosorb. Second, the extent of improvement varied with the experimental condition but was relatively uniform, from one surgical type to the next.

A somewhat comparable picture was obtained during the second experimental session, as is apparent in Table 3. Only one item is worthy of additional comment. Acuity remained better by 2 to 3 db. after the otologist had cleaned out the Hydrosorb which had been left in the ear than it had been at the outset of the first session. This effect is noted from 125 through 1000 cps, and it suggests that removing the Hydrosorb did not completely eliminate the influence of the ointment. We cannot say whether the prolonged presence of the ointment had modified the physical consistency of the drum or whether all Hydrosorb was not removed. The important point is that none of the responses obtained during the second session can be accepted as representing postoperative acuity uncomplicated by an influence from the ointment. Hence, only the first thresholds from the initial session, which are reported in Table 1, can be considered as the criteria of postoperative acuity against which to evaluate the effect of applying Hydrosorb.

In other respects the two experimental sessions yielded results which were highly equivalent. Not only were the mean levels of acuity nearly the same for a given condition of Hydrosorb placement, but the test-retest correlations for analogous con-

TABLE 1.—*Means and Standard Deviations of Air-Conduction Thresholds Obtained for Fenestrated Ears Prior to Application of Hydrosorb Ointment (Expressed in Decibels of Hearing Loss)*

		125	250	500	1000	2000	4000	8000
Class A (N=60)	m	25.6	18.8	24.7	25.3	22.2	44.1	42.2
	SD	11.0	9.2	7.3	6.3	9.0	17.6	22.3
Class B (N=23)	m	29.8	25.6	32.8	33.3	39.3	58.7	55.2
	SD	12.6	13.3	14.2	12.6	13.0	17.3	19.9
Class C (N=10)	m	30.0	33.5	40.5	43.0	49.5	73.0	69.0
	SD	8.9	10.3	8.8	10.3	19.2	21.1	19.1
Entire Group (N=93)	m	27.1	22.1	28.4	29.2	29.4	50.8	48.3
	SD	11.4	11.6	11.0	10.5	15.3	20.5	23.2

ditions were highly positive. Table 4 summarizes these correlations, by frequency, for each experimental condition. The interdependencies are sufficiently high so that we may justifiably restrict our discussion of comparisons between experimental conditions to the findings obtained during the first session. First, however, we should note that the test-retest consistency is less complete below 1000 cps than for frequencies from 2000 cps upward, where coefficients are uniformly better than 0.90.‖ The poorer correlations for low frequencies parallel the greater influence which Hydrosorb has on acuity at these frequencies, a fact discussed in the next section. The reason appears to be that fenestrated ears are more susceptible at low frequencies to temporary modification in acuity because of minor changes in the physical constants in the middle ear.

‖ The reader will recall that 1.00 represents perfect positive interrelation, while 0.00 means that the two factors are fully independent.

Effects of Different Placements of Hydrosorb

The simplest way of comparing the four conditions of Hydrosorb placement is to contrast the gains, relative to initial acuity, which characterized them. The subjects in the three surgical categories behaved sufficiently similarly so that only results for the entire group need be considered. Find-

TABLE 2.—*Means and Standard Deviations of Air-Conduction Thresholds Obtained During First Session for Fenestrated Ears After Application of Ointment (Expressed in Decibels of Hearing Loss)*

	Hydrosorb Condition		125	250	500	1000	2000	4000	8000
Class A (N=60)	II: Drum only	m	16.2	11.2	17.1	20.6	20.5	42.6	40.6
		SD	9.0	7.3	7.0	5.8	8.4	18.8	22.7
	III: Drum plus	m	14.4	9.5	16.4	19.3	20.0	42.3	41.7
		SD	9.1	6.9	6.3	5.9	8.3	18.6	22.6
	IV: Fenestra only	m	22.7	17.7	23.7	24.8	23.5	44.9	44.4
		SD	9.7	7.4	7.6	6.3	9.1	19.2	22.2
	V: Drum and fenestra	m	20.7	14.5	21.0	23.1	22.8	43.8	42.9
		SD	9.6	7.3	6.3	6.0	8.8	18.4	22.3
Class B (N=23)	II: Drum only	m	22.4	15.0	24.3	28.9	37.8	56.9	54.6
		SD	13.6	11.2	12.5	11.0	13.0	17.3	19.9
	III: Drum plus	m	19.6	16.4	23.7	28.9	36.3	57.8	57.2
		SD	13.0	12.5	11.6	12.2	13.4	17.7	20.2
	IV: Fenestra only	m	27.4	23.0	29.8	32.8	38.9	59.3	54.3
		SD	12.3	11.1	11.2	11.8	12.9	17.7	21.4
	V: Drum and fenestra	m	24.8	19.1	26.6	30.4	39.6	57.2	55.9
		SD	11.9	11.9	10.0	11.2	14.9	16.9	21.9
Class C (N=10)	II: Drum only	m	27.0	28.0	35.0	40.5	48.0	73.0	69.0
		SD	6.4	11.7	11.4	11.0	16.9	23.2	19.8
	III: Drum plus	m	25.0	26.5	33.5	41.0	49.5	72.5	72.0
		SD	12.8	10.5	10.5	11.8	16.2	22.3	19.0
	IV: Fenestra only	m	31.5	30.5	38.5	44.0	52.0	72.0	70.5
		SD	9.2	12.1	10.5	10.9	16.3	21.1	20.9
	V: Drum and fenestra	m	29.5	30.0	36.0	43.0	51.5	70.0	70.5
		SD	10.1	13.0	10.9	11.7	16.8	19.9	20.9
Entire Group (N=93)	II: Drum only	m	18.9	14.4	20.8	24.8	27.2	49.4	47.1
		SD	10.8	10.3	10.8	10.4	15.0	21.5	23.8
	III: Drum plus	m	16.8	13.0	20.0	24.0	27.2	49.4	48.8
		SD	11.2	10.5	10.1	11.2	15.0	21.5	24.0
	IV: Fenestra only	m	24.8	20.2	26.8	28.9	30.4	51.4	49.7
		SD	10.8	9.9	10.1	10.6	14.9	21.3	23.3
	V: Drum and fenestra	m	22.6	16.9	24.2	27.0	30.0	49.9	49.1
		SD	10.7	10.5	9.4	10.4	15.5	20.3	23.9

TABLE 3.—*Means and Standard Deviations of Air-Conduction Thresholds Obtained for Fenestrated Ears During Second Session (Expressed in Decibels of Hearing Loss)*

	Hydrosorb Condition		125	250	500	1000	2000	4000	8000
Class A (N=60)	III: Residue from earlier visit	m	18.6	12.2	17.2	20.2	20.8	42.9	41.7
		SD	7.7	7.1	6.8	6.4	8.5	18.3	24.6
	I: Ear clean	m	22.3	16.3	22.1	22.9	22.3	44.0	42.3
		SD	8.1	7.7	7.5	6.3	7.6	18.2	23.1
	III: Drum plus	m	14.7	10.2	15.7	19.7	19.6	42.8	43.0
		SD	7.8	6.9	6.5	6.0	8.0	19.1	23.8
	IV: Fenestra only	m	23.5	18.4	25.0	24.8	22.8	44.3	43.2
		SD	8.6	6.5	6.3	6.4	7.9	19.8	24.5
	V: Drum and fenestra	m	20.4	15.6	21.8	23.7	22.7	44.0	42.3
		SD	7.7	6.7	6.7	5.6	9.0	19.2	24.7
Class B (N=23)	III: Residue from earlier visit	m	25.6	18.9	24.8	29.1	38.0	58.9	54.8
		SD	13.4	13.0	10.3	11.5	13.6	16.9	19.8
	I: Ear clean	m	29.3	24.1	28.8	31.7	39.3	59.6	52.8
		SD	14.3	14.3	10.3	11.2	13.1	15.8	20.5
	III: Drum plus	m	20.9	16.6	23.0	26.7	35.6	57.4	52.0
		SD	11.6	10.6	11.2	11.6	13.5	17.2	21.2
	IV: Fenestra only	m	30.4	25.4	31.1	35.9	37.6	59.3	50.2
		SD	13.3	12.9	11.9	11.6	13.7	17.3	21.5
	V: Drum and fenestra	m	26.7	20.9	27.9	32.2	37.8	59.1	52.6
		SD	11.6	11.5	9.5	10.6	13.5	17.3	22.4
Class C (N=10)	III: Residue from earlier visit	m	27.0	23.5	31.5	40.0	50.5	71.5	71.5
		SD	9.3	9.2	11.0	13.2	16.8	21.2	18.3
	I: Ear clean	m	30.5	28.0	35.5	42.0	51.5	71.5	71.0
		SD	9.6	10.5	9.6	12.7	16.3	22.1	17.7
	III: Drum plus	m	23.0	20.5	31.5	39.0	51.5	77.5	73.5
		SD	9.0	7.9	10.0	11.2	16.3	21.7	16.9
	IV: Fenestra only	m	32.0	29.0	37.0	43.5	51.5	*	74.5
		SD	8.7	8.2	9.5	11.6	16.1	*	16.8
	V: Drum and fenestra	m	27.0	26.5	35.5	42.5	52.0	72.0	76.0
		SD	7.8	8.4	12.7	9.7	16.6	19.6	18.2
Entire Group (N=93)	III: Residue from earlier visit	m	22.2	15.0	20.6	24.5	28.3	49.9	48.1
		SD	10.3	10.0	9.7	10.8	15.3	20.9	24.9
	I: Ear clean	m	24.9	19.5	25.1	27.1	29.7	50.8	48.0
		SD	10.7	11.0	10.4	10.7	14.7	20.5	23.8
	III: Drum plus	m	17.1	12.8	19.2	23.5	27.0	49.5	48.5
		SD	9.6	8.9	9.9	10.4	15.3	21.3	24.4
	IV: Fenestra only	m	26.1	21.3	27.8	29.6	29.6	51.2	48.3
		SD	10.6	9.6	9.4	10.9	14.6	21.8	24.9
	V: Drum and fenestra	m	22.7	18.1	24.7	27.9	29.6	50.7	48.5
		SD	9.3	9.1	9.1	9.8	15.1	21.2	25.8

* Some thresholds not measureable.

ings are summarized in Figure 3 and Table 5, from which it can be seen that the following trends characterize the data.

First, as already mentioned, all conditions of Hydrosorb placement produced some improvement in the mean acuity of the group. However, improvement was limited primarily to frequencies from 1000 cps downward. Acuity remained almost unchanged at 4000 and 8000 cps, while at 2000 cps a gain appeared only when the fenestra was left unobstructed.

TABLE 4.—*Test-Retest Correlation in Air-Conduction Acuity Achieved in Ninety-Three Fenestrated Ears During Different Conditions of Hydrosorb Placement*

Condition	125	250	500	1000	2000	4000	8000
I: Ear clean	0.64	0.70	0.70	0.82	0.93	0.97	0.97
III: Drum plus	0.68	0.71	0.82	0.90	0.95	0.97	0.95
IV: Fenestra only	0.65	0.54	0.72	0.87	0.92	0.96	0.94
V: Drum and fenestra	0.62	0.62	0.69	0.84	0.92	0.97	0.94

$r_{.05}=0.21$, $r_{.01}=0.27$ (d.f.=91)

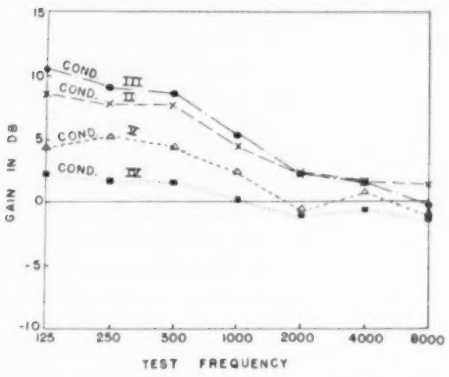

Fig. 3.—Mean threshold shift, for 93 fenestrated ears, obtained with the various positionings of Hydrosorb during the first session.

Second, as also mentioned, the amount of mean gain varied from one condition to another. Maximum gain was achieved when Hydrosorb covered the drum plus part of the endaural wall (Condition III). Almost as much gain resulted when only the eardrum was covered (Condition II). Gain dropped noticeably when both drum and fenestra were covered (Condition V), but it was still substantially greater than when the fenestra only was covered (Condition IV). In the latter instance, gain was so minimal as to have little practical importance.

Analysis was necessary to confirm whether the gains observed during the first experimental session can be considered true manifestations of change in acuity and to assess the relative influences of the four positionings of Hydrosorb. To this end, the statistical significances of the differences between mean acuities for the various experimental conditions were determined. The results are summarized in Table 6 in the form of *t* ratios.¶ The majority of the *t* ratios achieve better than 0.01 probability, while more than two-thirds exceed the 0.05 level.#

It is fair to conclude that real variations in air-conduction acuity differentiate the va-

¶ The *t* ratio was initially computed without regard for the correlation between conditions. This ratio was accepted if it exceeded 0.01 probability. When this latter condition was not met, the *t* ratio was recomputed for correlated scores. Correlations between conditions ranged from 0.40 to 0.73.

The *t* ratio is a number, derived from two sets of experimental data, which gives one the clue as to the confidence with which he can consider the two sets of data to represent real differences in performance. Without attempting a statistical explanation, one may say that a strong presumption of real difference is raised when groups of *t* ratio tend to exceed the 0.05 level and that ratios bettering the 0.01 probability can be similarly interpreted with even greater confidence.

TABLE 5.—*Mean Gains in Air-Conduction Acuity, in Decibels, Exhibited During First Session by Ninety-Three Fenestrated Ears Under Various Conditions of Hydrosorb Placement*

Condition	125	250	500	1000	2000	4000	8000
II: Drum only	8.2	7.7	7.6	4.4	2.2	1.4	1.2
III: Drum plus	10.3	8.9	8.4	5.2	2.2	1.4	−0.5
IV: Fenestra only	2.3	1.9	1.6	0.3	−1.0	−0.6	−1.4
V: Drum and fenestra	4.5	5.2	4.2	2.2	−0.6	0.9	−0.8

TABLE 6.—*Summary of t-Ratios for Differences in Air-Conduction Acuity Observed Among Experimental Conditions During First Session*

Conditions Compared	125	250	500	1000	2000	4000	8000
Ear clean (I) *vs.* drum only (II)	5.07	4.63	4.90	2.84	3.02*	2.34*	0.84*
Ear clean (I) *vs.* drum plus (III)	6.35	5.58	5.63	3.18	4.25*	2.34*	0.42*
Ear clean (I) *vs.* fenestra only (IV)	2.99*	2.83*	2.98*	0.68*	0.73*	1.00*	1.47*
Ear clean (I) *vs.* drum and fenestra (V)	2.64	3.08	2.86	4.00*	0.37*	1.50*	0.73*
Drum only (II) *vs.* drum plus (III)	2.73*	2.33*	1.57*	1.82*	0.22*	0.00	0.43*
Drum only (II) *vs.* fenestra only (IV)	4.57	5.32	6.42	4.87	3.74	3.24*	0.63*
Drum only (II) *vs.* drum and fenestra (V)	2.84	2.34	3.56	2.78	3.02	1.18*	0.10*
Drum plus (III) *vs.* fenestra only (IV)	6.02	5.93	6.95	5.44	4.05	3.87*	0.99*
Drum plus (III) *vs.* drum and fenestra (V)	4.35	3.51	4.20	3.49	3.34	1.17*	0.32*
Fenestra only (IV) *vs.* drum and fenestra (V)	3.23*	2.78	4.83*	3.21	1.37*	2.08*	0.74*

$t_{.05}$=1.99, $t_{.01}$=2.63 (d.f.=90)
*Correlation between conditions was considered in computing *t*-ratio.

rious experimental conditions. Furthermore, when one considers the clustering of significant *t* ratios, the generalizations given earlier regarding relative gains for different conditions may be accepted as meaningful.

The practical implications of these findings are easily stated. Speaking in terms of group trends, proper placement of ointment prostheses within fenestrated ears can produce real improvements in auditory acuity throughout most of the audiometric range. The optimal application, among those studied here, is to cover the drum membrane and adjacent portions of the medial wall of the tympanic cavity. Covering only the eardrum yields almost as good results. Care must be taken not to obstruct the new fenestra with ointment, since this reduces the improvement markedly. Paradoxically, less reduction has been noted when the eardrum has also been covered than when only the fenestra has been. In all instances, the most pronounced effects occur for frequencies below 1000 cps.

Individual Differences in Gain from Hydrosorb

While the foregoing generalization is useful, the clinician is most interested in knowing how the surgical outcome obtained by the individual case is related to the improvement he may expect from an ointment prosthesis. A good way of obtaining an indication of this relation is to evaluate appropriately the results for Condition III, which yielded the greatest gain. We turn now to such an evaluation.

TABLE 7.—*Coefficients of Correlation Between Postoperative Acuity for Fenestrated Ears (Condition I) and the Increment in Acuity when Hydrosorb Covers the Drum Membrane and Adjacent Bony Wall (Condition III)*

Frequency	Class A Cases (N=60)	Classes B and C Combined (N=33)	Entire Group (N=93)
125	0.75	0.17	0.47
250	0.67	0.30	0.43
500	0.56	0.42	0.43
1000	0.52	0.10	0.15
2000	0.39	0.21	0.21
4000	−0.06	0.04	−0.01
8000	0.07	0.14	0.02

$r_{.05}=0.25$, $r_{.01}=0.33$ (d.f.=58)
$r_{.05}=0.34$, $r_{.01}=0.44$ (d.f.=31)
$r_{.05}=0.21$, $r_{.01}=0.27$ (d.f.=91)

The coefficients reported in Table 7 indicate the correlation between the gain produced by Hydrosorb (Condition III) and the level of hearing prior to the application of an ointment (Condition I). Separate coefficients are given for the 60 cases in Class A, for the 33 subjects in Classes B and C combined, and for the entire group of 93 cases. The results allow us to examine the question as to whether the patients with the poorest postoperative hearing levels experience the greatest gains from ointment prostheses.

Considering the results for the entire group, one notes a moderate correlation for the lowest three frequencies. The coefficients for the remaining test frequencies may be considered essentially zero. Interestingly, the positive relationship disappears except at 500 cps when the analysis is limited to cases in Classes B and C. By contrast, when only the data for Class A cases are considered, the coefficients for low frequencies are highly positive and a significant interdependence persists through 2000 cps. Here coefficients are essentially zero only for 4000 and 8000 cps.

The foregoing discrepancies are meaningful when interpreted in the following manner. The distribution of postoperative hearing levels in a heterogeneous sample of fenestrated ears is determined primarily by the distribution of cochlear reserves present prior to surgery. Obviously, ointment prostheses do not move patients from one degree of cochlear reserve to another. They simply increase the mechanical efficiency of fenestrated ears, and this increase stays within moderate limits. Since our real concern is whether or not cases who fail most markedly to achieve the anticipated (or predicted) postoperative level show the greatest benefit from Hydrosorb, our judgment will be hampered if we start with a sample having a wide range of cochlear reserves. Our best estimate can be obtained by limiting our analysis to a population with highly homogeneous cochlear efficiency. In such a popu-

lation, here represented by the Class A cases, distribution of postoperative levels is predominantly an indication of failure to achieve maximum anticipated result. We may conclude from this line of reasoning and from the highly positive correlations shown for Class A cases in Table 7 that Hydrosorb tends to be most effective in those instances where, though surgically satisfactory, fenestrations have less adequately achieved full acoustical restorations. This situation is fortunate for the surgeon, since it means that an ointment prosthesis holds greatest promise in the instances where, probably for minor mechanical reasons, the auditory benefits of surgery have not been fully realized. The surgeon must, of course, remember that the foregoing generalization states a trend of probability rather than a promise of success in every case.

The same conclusion is supported when the data are treated so as to compare the conductive component which remains after fenestration with the gain induced by Hydrosorb. To explain, the reader will recall that fenestration does not restore hearing to the level of the cochlear reserve. As Davis and Walsh [17] first emphasized, there is a residual conductive loss which incorporates two components. One component is an inevitable handicap of about 20 db. due to disruption of the ossicular chain. The second component is an additional deficiency which represents the "surgical deficit," that is, the amount by which operation failed to achieve the full restoration to be anticipated. This "surgical deficit," which averages about 6 db., varies rather widely from case to case. Discrepancies in "surgical deficit" may be considered to represent the effect of minute but acoustically important differences in the ultimate mechanical conditions of fenestrated ears.

The so-called "air-bone gap," i. e., the discrepancy between the air-conduction and bone-conduction audiograms, is a means of estimating the relative magnitude of the conductive component which remains after fenestration.* We may assume that, as a statistical abstraction, variations in surgical deficit will reveal themselves as differences in "air-bone gap." A sample of the population trend for our 93 cases, insofar as "air-bone gap" is concerned,† is summarized in the final columns of Table 8. The table also summarizes the means and standard deviations of the thresholds from which the gaps were derived.

Confirmation of the earlier observation that Hydrosorb tended to have a greater beneficial effect when the residual conductive impairment was larger is found in Table 9. Here are reported the coefficients of correlation between "air-bone gap" and gain induced by Hydrosorb. One notes moderately high correlation for 250 and 500 cps. The relationship drops off for higher frequencies but maintains statistical significance except at 4000 cps.

Influence of Hydrosorb on Bone-Conduction Thresholds

Table 10 reports, for each experimental session independently, the mean shift in the bone-conduction acuity of the fenestrated ear as a result of covering the eardrum with Hydrosorb. One notes that at every test frequency the shift is mini-

* To obtain an absolute expression of the residual conductive component one must correct for the fact that, even after fenestration, the bone-conduction audiogram is not a perfect measure of cochlear reserve.[18] The exact magnitude of this correction probably varies with the individual, and we currently have no way of estimating it except as an average correction applicable to all subjects. There is no point in applying this average correction to the present data, since it would not change the relationship among subjects already revealed by their uncorrected measures of "air-bone gap."

† "Air-bone gaps" reported here were computed from the test results obtained immediately after the ear was cleaned during the first session. The thresholds for bone which are involved were those obtained without masking in the control ear. Bone acuity averaged slightly poorer with the control ear masked, probably primarily because of the psychological effects of masking described by Cochran,[19] but otherwise the relationships are similar.

TABLE 8.—*Means and Standard Deviations for Air-Bone Gaps Exhibited During the First Experimental Session by Ninety-Three Fenestrated Ears*

Test Frequency	Air Conduction		Bone Conduction		Air-Bone Gap	
	Mean Loss in Db.	SD	Mean Loss in Db.	SD	Mean in Db.	SD
250	22.1	11.6	7.1	8.0	15.0	8.7
500	28.4	11.0	7.9	10.2	20.5	9.2
1000	29.2	10.5	10.3	13.0	18.9	8.9
2000	29.4	15.3	13.7	15.5	15.7	10.1
4000	50.8	20.5	31.6	20.1	19.2	10.2

mal and it is not always in the same direction. The conclusion is obvious that the ointment prosthesis did not produce a meaningful shift in sensitivity to skull-borne vibration. This finding has no particular clinical significance, although it is of some theoretical interest that the mechanical modifications produced by the ointment induce mechanical changes in auditory sensitivity only when the stimulus is air-borne.

Stability of Results

Examination of the thresholds obtained on the control ears allows the conclusion that both the subjects and the audiometry involved in the present study possessed good reliability. Table 11 summarizes the test-retest findings for both air and bone conduction within the first experimental session, while Table 12 presents the comparison between the two sessions. These tables present mean thresholds for the entire group, differences between means, and coefficients of correlation indicating test-retest reliability.

The mean audiogram is a typical composite of what one would expect of the unoperated ears in a surgical series, as may be seen by comparing the present results with those obtained by McConnell and Carhart.[18] The "air-bone gap" is substantial, and the mean loss by air conduction is a little greater than 45 db. Average acuity for bone is near normal at low frequencies and tapers off at high frequencies.

The stability of results is revealed by the smallness of the differences between means and by the coefficients of correlation. The results within a single session indicate excellent test-retest reliability, particularly for air-conduction thresholds. Consistency is not quite so good between sessions, but it is still high enough so that we may have ample confidence in the reliability of both the subjects and the audiometry involved in the study.

TABLE 9.—*Coefficients of Correlation Between the Air-Bone Gaps Evidenced by Ninety-Three Fenestrated Ears and the Gains Produced when Hydrosorb Was in the Drum Plus Position (Condition III)*

Test Frequency	r*
250	0.51
500	0.49
1000	0.40
2000	0.33
4000	0.13

* $r_{.05}=0.21$, $r_{.01}=0.27$ (d.f.=91)

TABLE 10.—*Mean Shift in the Bone-Conduction Acuity of Fenestrated Ears Observed when Hydrosorb Was Applied to Eardrum*

Frequency	Shift in Db. During First Session*	Shift in Db. During Second Session*
250	0.4	−0.6
500	0.6	0.4
1000	1.0	0.3
2000	0.6	−0.3
4000	0.8	−0.3

* Positive shift indicates better mean threshold with ointment on eardrum.

Comment

Davis and Walsh[17] developed a graphic technique for estimating, from measures of speech reception, the minimal conductive deficit to be expected following fenestration. McConnell and

TABLE 11.—*Mean Thresholds Obtained in Two Successive Tests of Control Ears During the First Experimental Session, Differences Between These Mean Thresholds, and Coefficients of the Correlation Between Tests*

Test Frequency	First Test: Mean Loss in Db.	Second Test: Mean Loss in Db.	Difference Between Means	Coefficient of Correlation
		Air Conduction		
125	43.4	43.0	0.4	0.89
250	39.8	39.5	0.1	0.90
500	44.1	44.2	−0.1	0.93
1000	46.0	46.1	−0.1	0.96
2000	44.2	44.3	−0.1	0.97
4000	52.1	52.4	−0.3	0.97
8000	47.2	46.4	0.6	0.98
		Bone Conduction		
250	5.8	6.7	−1.1	0.71
500	8.3	8.7	−0.4	0.76
1000	16.9	15.9	1.0	0.78
2000	20.2	21.1	−0.9	0.87
4000	37.4	38.0	−0.6	0.94

$r_{1,2}$=0.27 (d.f.=91)

Carhart [18] extended the procedure by using pure-tone data. They concluded that the minimal conductive deficit after successful fenestration is 20 db. for all audiometric frequencies except 8000 cps, where it is 15 db. Rytzner [11] interpreted his data as indicating that Aquaphor applied to the fenestrated ear reduced the minimal deficit by 5 db. at 1000 cps and 10 db. at frequencies lower than 1000 cps, with no change from 2000 cps upward. The present study confirms the general trend reported by Rytzner, except that the minimal conductive deficit is reduced by 5 db. for the frequencies 250 through 1000 cps and 10 db. only for 125 cps (Fig. 4 and Table 13).

Our results confirm the general concept which earlier clinical investigators have accepted, namely, that the fenestrated ear is subject to a reduction of amplitude of motion at the basilar membrane attributable to the fact that sound entering the fenestra is partially cancelled by sound entering the round window. Increasing the acoustic differential between the two windows by covering the tympanic membrane with ointment appreciably increases auditory efficiency. Adding ointment also over the fenestra partially eliminates the increased differential, while ointment applied only to the new fenestra appears to produce little change in the differential.

TABLE 12.—*Mean Thresholds Obtained for the Control Ears During the First Session Compared with Mean Thresholds for the Second Session, Differences Between the Means for the Two Sessions, and Coefficients of the Correlation*

Test Frequency	First Test: Mean Loss in Db.	Second Test: Mean Loss in Db.	Difference Between Means	Coefficient of Correlation
		Air Conduction		
125	43.4	42.1	1.3	0.83
250	39.8	38.4	1.4	0.85
500	44.1	43.5	0.6	0.92
1000	46.0	45.6	0.4	0.94
2000	44.2	43.8	0.4	0.96
4000	52.1	53.6	−1.5	0.96
8000	47.2	46.5	0.7	0.97
		Bone Conduction		
250	5.8	5.2	0.6	0.48
500	8.3	9.1	−0.8	0.70
1000	16.9	17.3	−0.4	0.72
2000	20.2	19.9	0.3	0.82
4000	37.4	37.2	0.2	0.88

$r_{1,2}$=0.27 (d.f.=91)

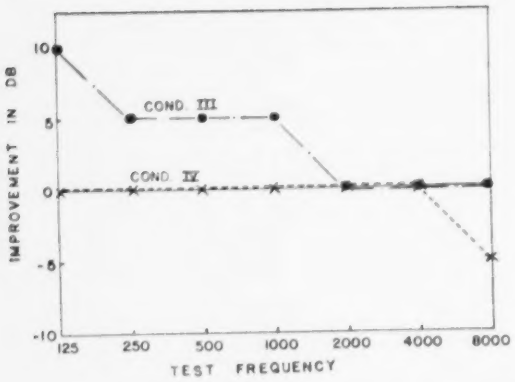

Fig. 4.—Estimate of the shift in minimal conductive deficit produced by applying Hydrosorb after fenestration.

The practical importance of these findings is obvious. The surgeon should view an ointment prosthesis placed against the tympanic membrane, but not covering the fenestra, as a supplementary technique giving a further gain, or "sharpening of the hearing," both when fenestration has not been fully successful from the acoustic standpoint and when the postsurgical level is most gratifying. Except for the rare case where there is an operative complication (such as postoperative cochlear deterioration from serous labyrinthitis) or a surgical failure (such as osseous closure of the fenestra), the physician should explore the value of an ointment prosthesis after every fenestration operation. Individual variations in effectiveness will be found, but every fenestrated ear stands a real chance of gaining an improved hearing level by this simple technique.

It should be mentioned that, at body temperature, there is a tendency for the ointment to slip away from contact with the tympanic membrane. Occasionally a Pseudomonas infection occurs beneath the ointment. These two disadvantages are lessened by 1% acetic acid and 10% yellow wax (beeswax) added to Hydrosorb ointment. The physician will find that warming the metal syringe ‡ will facilitate the injection of 0.5 cc. of this ointment along the floor of the meatus against the tympanic membrane, after which it is smoothed into place with a small cotton-tipped applicator. As soon as the ointment prosthesis migrates away from the tympanic membrane its blocking effect for the round window decreases and it should be replaced or replenished, usually about once every three months.

TABLE 13.—*Reduction in the Postoperative Minimum of Conductive Deficit Produced by Application of Hydrosorb*

Test Frequency	Ointment on Fenestra, Shift in Db.	Ointment on Drum, Shift in Db.
125	0	10
250	0	5
500	0	5
1000	0	5
2000	0	0
4000	0	0
8000	−5	0

Summary

A controlled statistical study of the effect of ointment prosthesis on the fenestrated ear confirms the value of this procedure for enhancing the hearing improvement following successful surgery. As a result of this technique the minimal conductive deficit to

‡ A single complication which occurred subsequent to the present study should be mentioned. During the injection of the ointment through a large-bore No. 12 angled blunt needle from a standard glass hypodermic syringe used for local anesthesia, the barrel of the syringe burst without warning and the needle impinged forcibly upon the horizontal portion of the facial nerve, producing immediate facial nerve paresis. Surgical exploration and decompression revealed a large hematoma of the nerve without interruption of continuity. After two months partial recovery of function became evident. As a consequence of this accident a metal syringe is recommended.

be expected following fenestration is nearer to 15 db. for the speech frequencies than the 20 db. indicated by Davis and Walsh and confirmed by McConnell and Carhart. The value of this simple procedure should be explored after every fenestration operation, and will be found worthy of routine use in the majority of these.

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Reversible Auditory Fatigue Resulting from Exposure to a Pure Tone

Part I

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Introduction

The obvious relationship between noise in industry and occupational deafness has resulted in considerable research being concentrated on the deafening effects of noise as measured by temporary threshold shift. As a result of this approach, the greater emphasis has fallen on the measurement of auditory fatigue resulting from exposure to intense sounds. The crucial question of the critical intensity level in effecting pathological damage to the ear has been answered only vaguely. Estimates of maximum noise levels to which the hearing organ may be exposed before suffering pathological trauma range between 80 and 100 db.[1-5]

However, threshold shift has also been demonstrated for exposure to stimuli at low intensities in studies of auditory fatigue resulting from stimulation by pure tones. In recent experimental work on poststimulatory auditory fatigue, a differentiation between deafness due to traumatic stimulation by extremely loud sounds and a decrease in sensitivity due to stimulation by sounds well within the tolerance range of human audition has emerged. Caussé and Chavasse[6] were the first to so differentiate temporary rises in auditory threshold following exposure to moderate suprathreshold intensities from permanent or relatively long-term threshold displacement following exposure to high suprathreshold intensities. Hood[4] in his paper on auditory fatigue elucidated on this difference by subjecting two measures, namely, the amount of threshold shift and length of recovery time, to empirical test. Hood believes his data lend substantiation to the differentiation made by Caussé and Chavasse in that a dividing line seems to be indicated between true fatigue of a physiological nature and "stimulation deafness" of a pathological nature. This transition point, below which auditory fatigue occurs and above which traumatic injury is probable, remains the elusive factor.

Threshold shift and length of recovery time are important measures in differentiating fatigue resulting from high and low level stimulus intensities, but they by no means exhaust the possibilities of the measures of differentiation. Davis and his associates[7] were able to show that for high levels of intensity the point of maximum fatigue appeared at a frequency one-half octave above the fatiguing tone. Caussé and Chavasse, on the other hand, found that the fatigue resulting from exposure tones of low stimulus intensity (20 to 40 db.) was symmetrical about a central point represented by the frequency of the stimulating tone. A measure of the sensation level at which this shift of approximately one-half octave takes place appears to be indicated in determining a critical fatiguing intensity. Harris'[8] findings support the use of sensation level rather than sound pressure level. These indicate that the level above the subject's threshold is the more useful parameter in specifying the fatiguing stimulus.

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Another measure which may be related to a critical fatiguing intensity is the recruitment of loudness phenomenon. An ear suffering sound trauma, whether it be permanent or temporary, exhibits recruitment of loudness. That is to say that, as the loudness is raised, evidence of impairment decreases until at a sufficient loudness level the fatigued ear behaves as though it were normal. This apparent normality is restricted, however, to loudness response; the impairment continues to manifest itself in terms of heightened sensitivity of the ear to fatigue and in subnormal discriminatory ability for speech sounds. If we accept the interpretation of Dix, Hallpike, and Hood,[9] Eby and Williams,[10] and Lundborg[11] that recruitment is evidence of the localization of the pathology in the cochlea, the presence of recruitment would indicate that fatigue is at least partly cochlear, and a measure of the amount of recruitment would, in a sense, be an indication of the amount of fatigue and/or trauma.

This paper is a report of an attempt to determine the critical fatiguing intensity for a 4000 cps pure tone of three-minute duration as measured by poststimulatory auditory fatigue using as measures (1) amount of threshold shift, (2) length of recovery time, (3) intensity of the exposure tone at the half-octave shift of the frequency of maximal fatigue, and (4) the amount of recruitment present after stimulation.

Procedure

Basic to the procedure of obtaining the desired measures was the recording of a continuous trace of the subject's threshold. The specific instrument used was an audiometer designed by Békésy[12] as modified by Reger[13] (Fig. 1). This in essence is an instrument which recorded graphically continuous threshold responses to an auditory stimulus of any given frequency both before and after exposure to signals at fatiguing levels.

Twenty-three young adults were used as subjects. The requirement of normal hearing and normal intensity difference limen was imposed. The criterion of a normal difference limen is that determined by Lundborg,[11] who states: "[a subject] . . . exhibits a normal difference limen . . . if the oscillations [as recorded by a Békésy audiometer] are equal within the entire frequency range . . . the amplitude between 6 and 9 db, with extreme limits of 5 to 20 db."

Threshold readings for test tones one-quarter octave below and one-quarter, one-half, and one octave above the exposure tone of 4000 cps, as well as for the exposure tone itself, were taken. The ear was stimulated for three minutes by the 4000 cps exposure tone at one of five sensation levels: 70, 80, 90, 95 and 100 db. The average threshold for the fatiguing tone was determined for 10 normal ears and this value taken as the reference for the sensation level settings. With the use of such an average sensation level for the

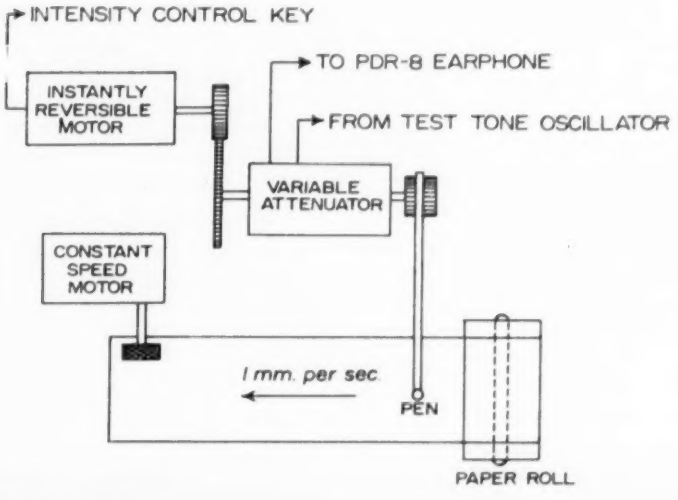

Fig. 1.—Diagram of the instrument used to record graphically the continuous threshold responses.

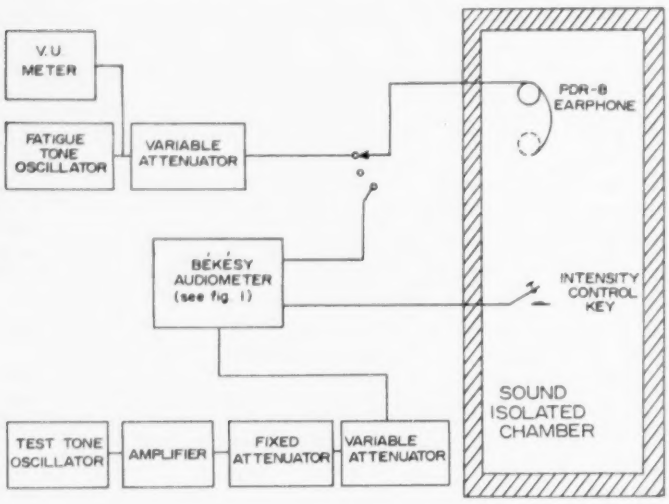

Fig. 2.—Block diagram of the complete experimental set-up.

fatiguing tone all subjects were exposed to the same sound pressure level.

Immediately after the cessation of the exposure tone, the changing course of the recovering threshold was recorded continuously for five minutes. The complete experimental set-up is shown in the block diagram of Figure 2. The exposure tone was generated by a Hewlett-Packard 200-D oscillator and passed through a Hewlett-Packard 350-A variable attenuator to the PDR-8 earphone. The second harmonic of the 4000 cps exposure tone (as measured by the Hewlett-Packard 300-A Wave Analyzer) was 60 db. down. Since the frequency response of the PDR-8 earphone is 20 db. down at 8000 cps, fatiguing effects due to harmonics cannot be considered a significant factor.

One tracing per day per ear was the order of procedure. Comparisons of day-to-day thresholds served as a check for cumulative effects, which were shown to be negligible.

Amount of Threshold Shift

The attenuator of the Békésy audiometer was set to change the intensity of the test tone at the rate of 4.3 db. per second. This means that for every 4 db. rise in threshold attributable to the fatigue tone approximately one second would be required for the shift to be recorded on the response trace. This measure is dependent also on the attentiveness and reaction time of the subject. The comment of sophisticated listeners indicated that the increase in the rate of intensity change from 2 db. (see Békésy) to 4.3 db. per second tended to keep them more alert as the tone "appeared" and "disappeared" relatively rapidly.

To get the initial threshold shift within an even shorter time, the level at which the test tone was started, following stimulation by the fatiguing tone, was deliberately set considerably above the subject's unfatigued threshold at that frequency. Using these procedures, the measure of threshold shift was obtained within five seconds or less after cessation of the exposure tone.

In a later experiment* it was demonstrated that this raising of the test tone above the subject's prestimulatory threshold following exposure to the fatiguing tone appeared to create an additional fatigue effect. Since this effect seemed to be occurring while it was being measured and was confounded with poststimulatory fatigue, Hood's [4] terminology of perstimulatory fatigue has been used. Thus the amount of threshold shift was considered poststimulatory plus overlaid perstimulatory fatigue when the test tone was raised above the subject's unfatigued threshold immediately following cessation of the exposure tone. For convenience in reference, all data relating to threshold shift measured in this

* To appear as Part II of this paper.

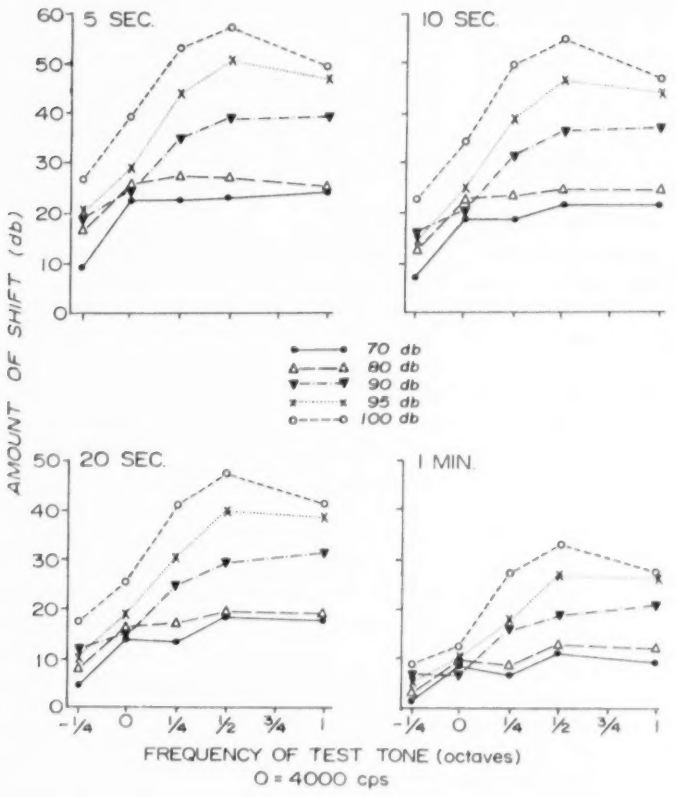

Fig. 3. — Average threshold shift for 23 subjects, plotted with the sensation level of the fatiguing tone as the parameter.

manner have been called "overlaid perstimulatory" fatigue.

Figure 3 shows average threshold shift (overlaid perstimulatory fatigue) for the 23 subjects, plotted with the sensation level of the fatiguing tone as the parameter. Each of these functions represents the distribution of fatigue around the frequency of the exposure tone for a designated level of the exposure tone. A three-factor analysis † of the amount of shift five seconds or less after cessation of the exposure tone indicates that this threshold shift does not increase equally at all frequencies tested as the level of the fatiguing tone is raised. The probability of differences this large occurring by chance is less than 1 in 1000. This changing pattern of fatigue with increasing level of the exposure tone corroborates the findings of Hood ‡ and Jerger § and makes it feasible to look for a level of the fatiguing tone and/or frequency of test tone where a sudden increase in the amount of fatigue is demonstrated. Figure 3 indicates this disproportionate increase in fatigue for the stimulating tone, when measured 5, 10, and 20 seconds after exposure, appears to take place for sensation levels greater than 95 db. This is also the general pattern of Hirsh and Bilger's [14] results using a 1000 cps stimulating tone and measuring "temporary hearing loss" one-half octave above. There is a more dramatic over-all increase in fatigue for test tones one-half and one octave above the fatiguing tone. These additional fatigue effects are of the order of 12 db. between the 80 and 90 db. sensation level of the fa-

† Exposure levels by test-tone frequencies by subjects, using the amount of threshold shift as the criterion measure.

‡ Reference 4, p. 12.

§ Reference 5, p. 42.

tiguing tone for a test tone one-half octave above the frequency of the exposure tone at the five-second interval. If such an increase in the amount of threshold shift is related to a critical fatiguing intensity, the level at which the increase occurs at one-half to one octave above the stimulating tone would be the better measure. As can be seen, such an increase occurs for a fatiguing tone sensation level greater than 80 db.

Amount of Recruitment

The Békésy audiometer permits the recording of the subject's variability around his absolute threshold of hearing. Ears manifesting the recruitment of loudness phenomenon exhibit a decreased variability around threshold when measured in this manner. The modified Békésy audiometer used in this experiment was set to change the intensity level continuously at a rate of 4.3 db. per second. Lundborg's data [11] are based on an intensity change of one 2 db. step per second. However, the swings of the normal subjects used in this experiment ranged in amplitude between 5 and 15 db., and the oscillations were equal, from sample to sample, for each of four discrete samples within the entire frequency range. It was therefore assumed that the changed mode from stepped to continuous variation and the increased rate of intensity change did not differ materially from Lundborg's criterion measures of a normal difference limen for intensity (presented earlier in this article).

For a constant intensity change, the number of swings above and below threshold per unit of time will be an inverse function of the variability about threshold. Accordingly, as a measure of the amount of recruitment after exposure to the fatiguing tone, the number of oscillations for a 30-second sample within the first minute after the cessation of the stimulating tone was determined. This measure was compared with the measure (determined in a similar fashion) for the unfatigued threshold of the test tone for a 30-second interval within the first minute preceding the exposure tone. The ratio of these two measures was computed by dividing the measure for the unfatigued threshold into the measure for the fatigued threshold. This quotient (multiplied by 10 to eliminate unwieldly fractions) is identified as the recruitment factor

$$\text{(R. F.} = \frac{\text{Fatigued}}{\text{Unfatigued}} \times 10)$$

and is taken as the amount of recruitment present following stimulation by the fatiguing tone. For example, a recruitment factor of 10 would mean that the variability about threshold had not altered from prestimulatory to poststimulatory measurement; a recruitment factor of 20 would indicate that the poststimulatory variability about threshold is one-half as great as the prestimulatory variability.

Figure 4 is the recruitment factor plotted as a function of the test-tone frequency (the sensation level of the fatiguing tone as the parameter) for the 1st half-minute period and the 10th half-minute period of the recovery tracing. From the lower graph it is apparent that the recruitment factor was considerably reduced after five minutes' recovery, although, on the average, it had not returned to its prestimulatory level (R. F. = 10). Within one minute after cessation of the fatiguing tone (upper figure), recruitment is marked and appears to change with increasing level of the fatiguing tone. Statistical analysis of the results ‖ indicates that the changing recruitment factor does not follow a consistent pattern with increasing levels of the fatiguing tone. Here again the interest is in determining at what level of exposure the recruitment measure shows a marked change. As is shown at sensation levels of the fatiguing tone greater than 80 db., recruitment increased disproportionately for a test tone one-half octave above the frequency of the exposure tone. Thus it appears that a sensation level of exposure greater than 80 db. for a 4000 cps tone of three minutes' duration causes significant changes in the course of the fatigue effect

‖ A three-factor analysis—exposure levels by test-tone frequencies by subjects— using the recruitment factor as the differentiating measure.

as measured by this recruitment factor as well as for measures of the amount of threshold shift. Rüedi [15] also notes a "narrowing of the difference limen" as measured on a Békésy audiometer for a test tone of 4000 cps after exposure to a white noise at 95 db. SPL.

Shift of the Frequency of Maximal Fatique

The view of the data shown in Figure 3 graphically demonstrates a shift of the frequency of maximal fatigue one-quarter and one-half octave above the frequency of the fatiguing tone for exposure tone sensation levels greater than 80 db. This level agrees with the level noted for increase in the amount of threshold shift and recruitment factor for the one-half octave (re 4000 cps) test tone. Thus this occurrence of the shifting of the frequency of maximal fatigue to test-tone frequencies above the exposure tone at sensation levels greater than 80 db. may well be another indication that this sensation level is near the critical fatiguing intensity for a pure tone of 4000 cps of three minutes' duration.

Recovery Slope Index

The changing course of recovery was recorded for five minutes following the cessation of the fatiguing tone. Figure 5 shows the recovery from fatigue for each test frequency as a function of time after exposure to a 100 db. fatiguing tone. As can be observed, recovery is more rapid for the first minute after cessation of the fatiguing tone and then levels off as the ear gradually returns to normal sensitivity.

In the recent literature on the recovery from fatigue a reversal in the direction of the recovery slope ("bounce") has been

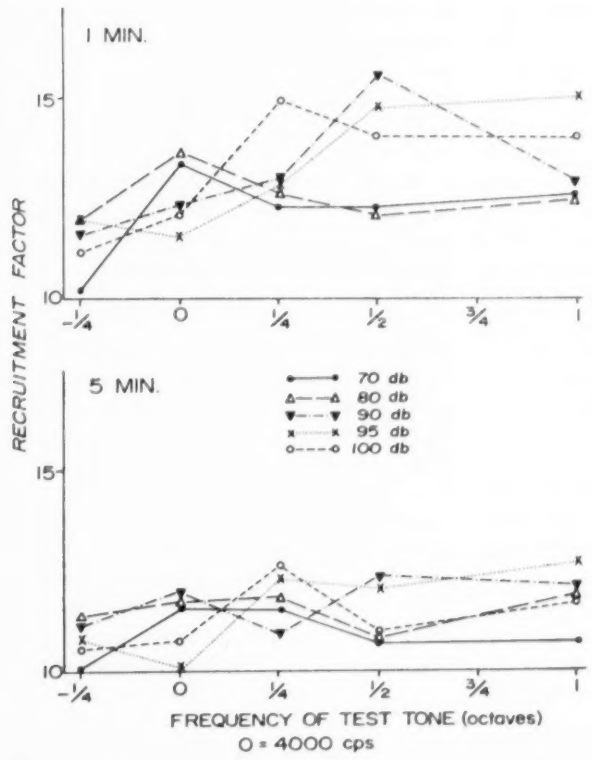

Fig. 4.—Average recruitment factor for overlaid perstimulatory fatigue measured within two time intervals after the cessation of the fatiguing tone. The parameter is the sensation level of the fatiguing tone.

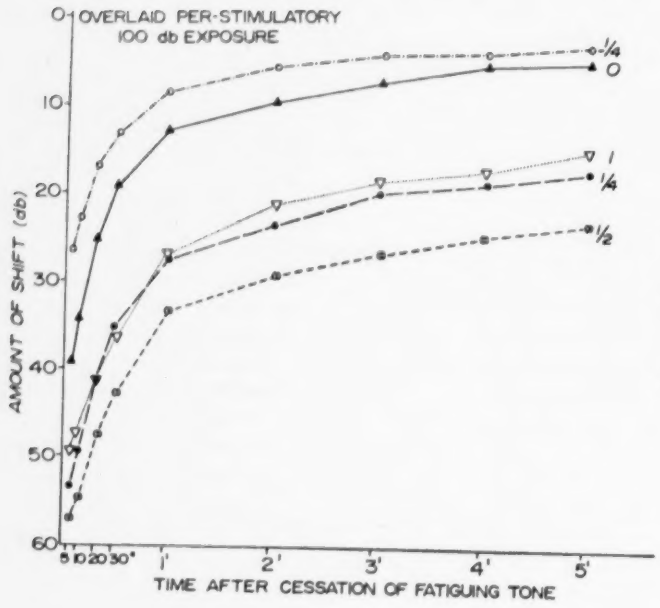

Fig. 5.—Recovery from overlaid perstimulatory fatigue as a function of time (in minutes) after cessation of exposure to a 4000 cps tone at a sensation level of 100 db. for three minutes. The parameter is the frequency of the test tone in octaves (0=4000 cps).

noted between one and three minutes after cessation of the fatiguing stimulus.[5,14,16-18,19] This phenomenon of the "recovery curve bounce" has been reported to occur at a large number of frequencies and for a variety of exposure stimuli. From inspection of Figure 4 it is quite obvious that no such recovery curve reversal took place in this study. Harris[20] also does not report such a pattern in his results. We have searched for pertinent differences in our technique and subject population, and can find no satisfactory explanation other than the rate of intensity change of 4.3 db. per second seems to be faster than that used by other investigators.¶

Any attempt at a rational explanation is hampered by failure to find in the literature a consistent picture of the frequencies, levels, and durations of stimulation leading to the bounce.

As an index for the recovery of the ear to normal sensitivity after stimulation by a 4000 cps tone, the difference between the amount of threshold shift at the one-minute interval following the cessation of the fatiguing tone and the amount of shift measured immediately after cessation of exposure (five seconds or less) was computed. This difference was taken as the index for the recovery slope.

These differences plotted for each fatiguing tone level at each test-tone frequency give a family of curves (Fig. 6) denoting the distribution of fatigue recovery rates. Upon statistical analysis, the assumption that the recovery rate for each test frequency demonstrates an equivalent change for increasing levels of the fatiguing tone was sustained by the nonsignificant F-ratio obtained. Evidently rate of recovery from fatigue does not display the sudden change at a particular exposure tone level which was noted for the measures of threshold shift and recruitment factor for "overlaid perstimulatory fatigue." However, the hypothesis that the change in recovery rate over each exposure level for all test frequencies is not a chance occurrence is substantiated by the results of the analysis of variance. The increase in recovery rate thus parallels the similar increase noted for

¶ Jerger[5]: 1 db. per second; Lierle and Reger[19]: 2 db. per second.

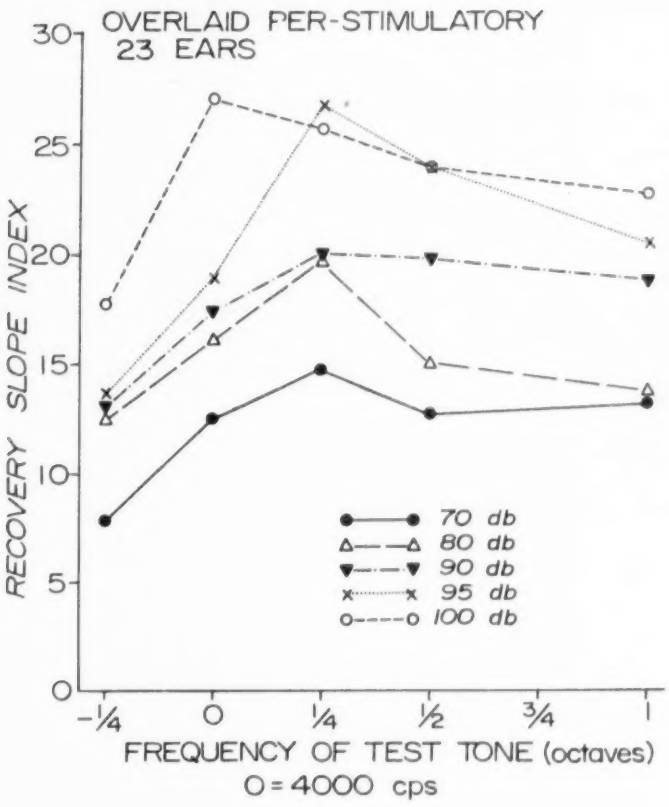

Fig. 6.—Average recovery slope index (0-1 minute) for overlaid per-stimulatory fatigue. The parameter is the sensation level of the fatiguing tone.

threshold shift. In addition, the expected change in recovery rate over each frequency for all fatiguing tone levels is demonstrated.

Summary

The results of Part I of this study indicate a sensation level of 80 db. as approximating a critical fatiguing level for a three-minute exposure to a tone of 4000 cps for the following reasons:

(*a*) Sensation levels of the 4000 cps exposure tone greater than 80 db. appear to produce a significant change in the fatigue pattern as delineated by amount of threshold shift and recruitment factor.

(*b*) For stimulating tone levels greater than 80 db., the frequency of maximal fatigue shifts from one-fourth to one-half octave above the stimulating tone frequency.

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An Auditory Loudness Recruitment Test Battery

Analysis and Comparison of Subtests

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The significance of auditory recruitment within the framework of auditory theory today is claiming the attention of a large number of laboratories and clinics. Data relating to the manifestations of the recruiting person are being analyzed. Tests are being devised to indicate the presence or absence of recruitment in the person with impaired hearing. A survey of the literature indicates that recruitment tests can be subdivided into tests of loudness balance, difference limen, and speech sound discrimination.

The purpose of the present investigation was to establish, by means of more rigorous statistical analyses than have hitherto been reported, the capability of a series of tests to distinguish between normal hearing persons and those whose auditory perception is characterized by recruitment in the loudness function. The following tests were subjected to such statistical analyses: (1) range of comfortable loudness (RCL) test, (2) difference limen (DL) test, and (3) speech sound discrimination (SSD) test.

Specifically, the attempt of the investigation was to determine the significance of the factors considered as main effects in each of the three tests. In the range of comfortable loudness test, the factors that were investigated were those of groups (normal *versus* impaired hearing), the subjects within each of the two groups, and the ear of the subject being tested. In a similar manner, the factors utilized in the difference limen test for analysis were groups, the subjects within each of the groups, frequencies, sensation levels, the direction (ascending-descending characteristics) of the stimulus presentation, and the ear of the subject being tested. The speech sound discrimination test involved testing the factors of groups, the subjects within each group, sensation levels, and the ear being tested. Through analysis the significant factors and the interactions of factors involved in each of the three tests were determined for discussion.

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Community Speech and Hearing Center (Dr. Spuehler), Purdue University (Dr. Hanley).

Procedure

The three tests which comprised this investigation were administered serially to individual subjects. While a presentation in random order was a desideratum, restrictions on the availability of laboratory space made it necessary to administer the RCL test initially. However, the DL and SSD tests were administered randomly with respect to subjects. All tests were administered in acoustically treated rooms of the Purdue Speech and Hearing Clinic.

Two groups of subjects, control and experimental, were utilized in this study. The control subjects were five university students whose hearing was normal. Subjects in the experimental group were four in number, chosen on two bases: pattern of hearing loss and performance on a Békésy audiometric test.

The pattern of loss for the subjects in the experimental group was one of marked impairment in the higher frequencies, with the threshold breaking away from normal at 2000 cps or slightly higher. On the Békésy audiometric examination, the subjects manifested fine discrimination around their thresholds. None of the subjects in the control group had a medical history which would be predictive of hearing impairment,

while two of the four experimental subjects related that they had been exposed, by reason of military experience, to severe acoustic trauma. The third subject had a history of severe fever diseases in infancy, sufficient to account for the measured impairment, while the fourth subject was unable to relate any unusual hearing history. The age range for the control group was 19 to 21 years of age; for the experimental group, 22 to 37 years.

In this investigation the two ears of the subject initially were considered to be independent, and separate auditory tests were administered. Later statistical analysis of the data failed to substantiate the hypothesis of independence. However, two-ear testing was justified as a test for auditory fatigue. Threshold shift in the second ear, if found, would have been indicative of such fatigue.

Each division of the investigation involved one of the three types of tests mentioned. The component instrumentation for each test is described in the following order: (1) range of comfortable loudness equipment, (2) difference limen equipment, and (3) speech sound discrimination equipment.

In the RCL test, a standard pure-tone audiometer possessing a sweep characteristic on the intensity dial was used. The audiometer was used in conjunction with calibrated earphones, Permaflux, Type PDR-8, High Fidelity, in a manner which allowed only one of the phones to be activated with the tone signal. A motor-driven gear reduction unit with a hand-controlled reversing switch was employed as a remote control of the intensity dial of the audiometer. By virtue of the hand-controlled reversing switch, the sweep intensity characteristic of the audiometer could be made to increase or decrease at a rate of 2 db. per second. A coupling box was utilized in the circuit to permit the testing of either ear without the necessity of removing the headset.

In the DL test, it was necessary to provide an auditory stimulus characterized by pulsations, regularly increasing and decreasing in magnitude. These would constitute both ascending and descending difference limen stimuli, providing the subjects with opportunity to discriminate both of the following stimulus characteristics: (*a*) steady-state following pulsation and (*b*) pulsation following steady-state. The fineness of discrimination or size of difference limen would be dependent upon the amount of amplitude modulation required for the subject to perceive "sameness" or "warble" in the stimulus.

A triangular wave from a Hewlett-Packard Low Frequency Function Generator and a sinusoidal wave from a Hewlett-Packard Audio Signal Generator, Model 205AG, were used as the components of the test signal. The sine wave of 500 cps at a level of 60 db. was used as a reference around which a triangular wave of 500 cps varied from 55 to 65 db. Before the two waves were combined, a mechanical sampling device was inserted into the circuit of the two signal generators. Samplings of each wave source were then recorded on an Ampex, Model 400, tape recorder every $\frac{1}{10}$ second, allowing a change of 0.25 db. to occur in the triangular wave between samples. The resultant wave resembled a changing square wave, with the reference value fixed and the excursion of the wave varying from a +5 db. to a −5 db. around the reference tone. The 1000, 2000, 3000, and 4000 cps test tones were then recorded in the same manner. With each change of the sinusoidal or reference wave there was also a similar change in the triangular wave with regard to frequency.

A Sound Apparatus Company High Speed Level Recorder, Model HPL-E, was employed to yield a graphic representation of the intensity variations of the input signal being heard by the subject. A signaling device was used by the subject to interrupt the connection between the stimulus source and the HPL-E recorder when steady-state and warble signals were perceived. When this device was used, the stylus on the HPL-E would drop to the "off" position, producing a sharp demarcation line from the usual pattern being recorded by the HPL-E on the waxed recording paper.

The SSD test was presented to the subjects over the speech reception testing equipment of the Purdue Speech and Hearing Clinic. The instrumentation, as described by Steer and Doyne,[11] consisted of a preamplifier equipped with several inputs and a power amplifier with outputs for both speaker and headphones. An Ampex, Model 400, tape recorder was used to present the test to the subjects seated in a separate room. Only one side of a pair of Type ANB-H-IA headphones was used during the testing.

The circuit reference level was adjusted by a V. U. Meter, and the sound pressure level of the presentations of the test lists was controlled by a 110 db. attenuator.

The speech sound discrimination lists used contained nonsense syllables of the consonant-vowel characteristic. The back, lax vowel heard in the word "hub" remained the same throughout all the presentations. The 10 consonants utilized were "p," "t," "k," "g," "f," "s," "tch," (as in "clutch"), "sh" (as in "ship"), "j" (as in "jug"), and "th" (as in "thin"). A random presentation of the items was recorded onto tape by means of the Ampex recorder and divided into 20 groups of 10 items, or a total of 20 lists. Each consonant was presented once in each of the 20 lists. A practice tape was also recorded with a random presentation of the consonants to be used in the test.

Method

Range of Comfortable Loudness.—Tones of five different frequencies were presented. The order of presentation was as follows: 1000, 3000, 500, 2000, and 4000 cps. The staggered order of presentation was used in an attempt to prevent fatigue at specific points on the basilar membrane of the subjects. A further safeguard against fatigue was the experimenter's interruption of the tone after each trial by a subject.

Five readings were taken for both the most comfortable loudness level (MCL) and the uncomfortable loudness level (ULL) at each frequency. Each level found by the subjects was noted and if all five readings were found to be within a 3 db. range at a given frequency, the average of the responses was taken as the reading for that frequency. If any set of responses covered a wider range than the predetermined 3 db., further sets of five readings were taken until the responses fell within the required span. When the last frequency (4000 cps) had been tested in the first ear, a recheck was made of the 1000 cps tone to ensure the consistency of the subject's evaluation. If the recheck was not within 3 db. of the previous readings, the 1000 cps trial was reestablished and the next, or 3000 cps, tone was rechecked. The rechecking was continued until the readings recorded were consistently within the 3 db. range.

When both MCL and ULL had been determined for the two ears of the subject in all frequencies, each MCL was subtracted from the corresponding ULL for that frequency. This difference was listed as the value of the RCL for the subject.

Difference Limen.—The ascending order of frequency presentation was 500, 1000, 2000, 3000, and 4000 cps. Eight sound pressure levels were tested in each frequency at 5 db. intervals. They were 15, 20, 25, 30, 35, 40, 45, and 50 db. above the subject's threshold. Each ear was tested singly.

When the test had been completed, results of the responses for each subject were noted. The representation of the wave on the recording paper was such that a 1 mm. rise of the stylus equalled a 1 db. rise in sound pressure level. Points on the recording paper at which the subjects signalled perception of steady-state and warble tones were measured to the nearest millimeter. An ascending and a descending order of presentation was taken into consideration in the recording of the results. The ascending group was taken as the part of the wave which went from the steady-state to the warble tone, and the descending group was taken as that part of the wave which went from a warble tone to a steady-state tone. An average of the two readings for both

the ascending and descending procedures was entered as a final result for the subject.

Speech Sound Discrimination.—The first of the recorded consonant-vowel syllable lists presented was used to determine the detectability threshold. At the outset, a level of full attenuation was used. Then the attenuation was reduced so that an increasing order of sound pressure levels was presented to the subject, who signalled when the stimulus was perceived.

The level of attenuation was then adjusted so that the first discrimination list would be given at a level 2 db. above the previously determined threshold of detectability. At the end of the first list, the tape was interrupted and the subject was informed that the second list was to begin. The second list was presented at a level of 4 db. above the subject's threshold. Each succeeding list was presented with an increment of 2 db. until the 15th list had been completed. At this time, the intensity increment for the final five lists was increased to 10 db. Thus, the range covered was from 2 to 82 db. above threshold of detectability.

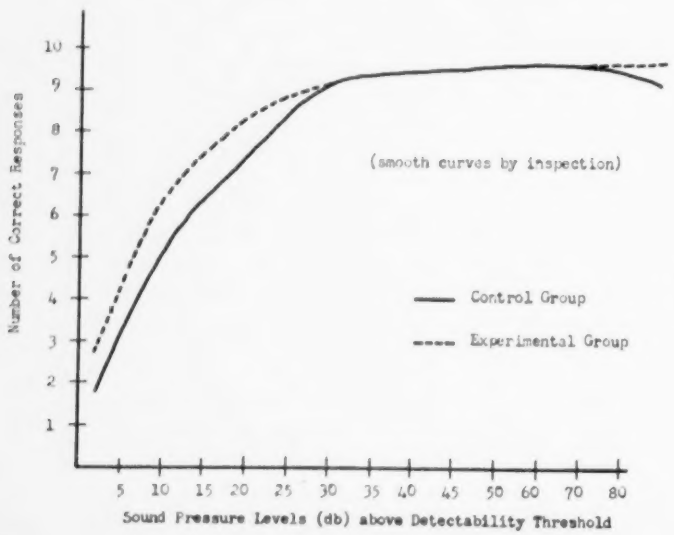
The test lists were scored according to the number of items correct per list. These list scores were entered appropriately in a table according to the subject, group, ear being tested, and the sound pressure level of the presentation.

Results

Results obtained for all the subjects on each of the three tests were combined appropriately, and arithmetic means were calculated for the main effects. In this study the main effects were those attributable to groups (experimental and control), frequencies, sensation levels, and ears. An analysis of variance technique was used to test the results for statistical significance.

In the case of the RCL test, a four-factor analysis of variance technique was used in which groups, subjects within groups, frequencies, ear of the subject, and interactions among the main effects were tested for significance.

In the DL test, a six-factor analysis of variance technique was applied in the statistical treatment of the data obtained. The factors involved were groups, subjects within groups, frequencies, sensation levels, the ear of the subject, and the direction (ascending or descending) of presentation of the test tone. The interactions among the main effects were also analyzed.



Graphic plot of speech sound discrimination test results.

TABLE 1.—*Mean Scores by Frequency in RCL Test*

	Frequency									
	500		1000		2000		3000		4000	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Control	47.4	6.5	49.4	6.5	46.9	7.8	45.7	5.0	46.4	7.8
Experimental	34.3	12.7	37.5	10.0	33.3	11.8	21.7	6.1	12.9	5.2
All subjects	41.6		44.1		40.9		35.0		31.5	

Finally, in the speech sound discrimination test, two separate analyses were conducted. The dual analysis was selected to permit scrutiny at two specific points in the discrimination curve. The first point to be examined was the origin of the curve, which involved the initiating segment and the slope of the curve rising away from the origin. The second analysis was concerned with the plateau found at the upper end of the discrimination curve. Both analyses included a four-factor treatment in which the main effects were groups, subjects within groups, sensation levels, and the ear of the subject. Interactions among the main effects also were analyzed.

Null hypotheses were tested in each of the three sections of the experiment. In each application, the null hypothesis was that there were no significant differences in the variables measured due to the main effects or interactions.

Range of Comfortable Loudness.—In the RCL experiment, the null hypothesis was rejected for results involving groups, frequencies, and frequencies by groups. As can be seen in Table 1, the totals for both groups were found to decrease in magnitude with frequency, except for a reversal involving 500 cps. On closer inspection it is seen that the experimental group had the greater effect upon the decreasing size of the RCL with frequency. This observation is substantiated by the findings of 1% significance for the difference between groups (experimental and control) and 5% significance for the differences among frequencies and the interaction of frequencies-by-groups, revealed in the analysis of variance, Table 2.

Inspection of Table 2 shows that not only were the mean values for groups significantly different but the difference apparently increased with frequency, most notably at 3000 and 4000 cps. The specific RCL values found for the experimental group were markedly different from results reported by previous investigators. It should be noted that the value of 15 db. as the determinant of the presence of recruitment reported by Bangs and Mullins[1] could apply only to the results found in the 4000 cps tone in this experiment. The 3000 cps tone had a mean value of 21.7 and a standard deviation

TABLE 2.—*Analysis of Variance of Average RCL*

Source of Variation	df	Sum of Squares	Mean Squares	F	Significance Level
Gr*	1	16864.7	16864.7	55.79	1%
S c Gr†	7	2116.2	302.3		
Ear	1	2130.4	2130.4	1.57	
Ear × Gr	1	4283.6	4283.6	3.16	
Ear × S c Gr	7	9493.8	1356.3		
F‡	4	3217.2	804.3	2.71	5%
F × Gr	4	3679.9	919.9	3.10	5%
F × S c Gr	28	8309.3	296.8		
F × Ear	4	2130.4	532.6	1.57	
F × Ear × Gr	4	1790.4	447.6	1.32	
F × Ear × S c Gr	28	9493.8	339.1		

* Gr=groups.
† S c Gr=subjects within groups.
‡ F=frequency.

Table Values of F
0.01—(1, 7) df—12.20
0.05—(4, 28) df—2.69

of 6.1 db. Examination of the individual results against the Bangs and Mullins criterion reveals that only two ears of the experimental group could be said to be recruiting at the 3000 cps frequency.

The dispersion of the standard deviations around group means for the tested frequencies can be seen to be fairly constant for the control group, while a decreasing trend with frequency may be observed in the experimental group.

The analysis failed to reveal any difference between ears for subjects.

Difference Limen.—As recruitment has been described, the experimental group tested in this investigation should have displayed a smaller DL than the control group. As revealed in the means and standard deviations of the value of the DL for each test frequency in Table 3, significance was established at the 5% point for the effects of groups (experimental and control) and direction (ascending and descending) of presentation of the stimuli. Furthermore, the supposition that the DL would decrease as the sensation level and frequency increased was supported. Though the inverse relationship was found between the factors of frequencies and sensation levels, it should be noted that the values found for the experimental group were consistently lower than those of the control group. Differences between ears for subjects were found not to be significant.

A common level which can be used for a comparison of results from this study with results from other studies is a tone of 40 db. at 4000 cps. Jerger [8] reported a DL of 0.5 db. for the recruiting subject; Denes and Naunton [2] reported a DL of 2.0; Lüscher and Zwislocki [9] reported a DL of 0.6, and Palva [10] reported a DL of 1.7 db. It is interesting to note that where discrepancies exist in the literature there are also differences in the experimental designs utilized. In the Jerger technique the subjects are asked to indicate a difference between the two tones while the presentation is given from a point of no modulation to a fully modulated value. Denes and Naunton, and Palva reported results utilizing a dual tone, the modulation of which decreased in amplitude to a point of constant intensity. The ascending warble in the present study is somewhat comparable to the Jerger technique, whereas the descending warble is comparable to the Denes-Naunton and Palva stimuli. As previously mentioned, the main effect, direction of the tone presentation to the subject, was found to be significant both in the experimental group and in the control group. The significance of the interaction of the direction of tone presentation by groups also was noted. The data were analyzed with regard to the values obtained at 4000 cps at a sensation level of 40 db. for both the ascending and descending presentations. A DL of 1.7 for the descending technique and a DL of 0.7 for the ascending technique were found for the experimental group. These results provide very close correspondence with the results cited above.

TABLE 3.—*Mean Scores by Frequency and Sensation Level on DL Test*

	Frequency									
	500		1000		2000		3000		4000	
Sensation Level in Db.	Cont.	Exper.	Cont.	Exper.	Cont.	Exper.	Cont.	Exper.	Cont.	Exper.
15 mean	3.0	1.8	2.7	1.5	2.5	1.6	2.7	1.8	2.5	1.4
S.D.	0.13	0.18	0.15	0.16	0.14	0.18	0.16	0.22	0.13	0.13
20 mean	2.7	1.7	2.5	1.6	2.5	1.5	2.5	1.5	2.3	1.3
S.D.	0.16	0.21	0.14	0.19	0.17	0.17	0.15	0.17	0.14	0.14
25 mean	2.6	1.5	2.4	1.4	2.3	1.4	2.3	1.3	2.1	1.2
S.D.	0.24	0.19	0.14	0.17	0.16	0.14	0.16	0.16	0.14	0.15
30 mean	2.5	1.4	2.2	1.4	2.2	1.3	2.3	1.2	2.0	1.2
S.D.	0.16	0.18	0.13	0.21	0.15	0.14	0.16	0.13	0.11	0.16
35 mean	2.2	1.5	2.1	1.4	2.1	1.3	2.1	1.2	1.8	1.2
S.D.	0.16	0.17	0.15	0.18	0.15	0.17	0.16	0.19	0.16	0.17
40 mean	2.1	1.4	2.0	1.3	2.0	1.2	1.9	1.2	1.7	1.1
S.D.	0.15	0.17	0.16	0.18	0.15	0.15	0.14	0.15	0.11	0.16
45 mean	1.9	1.2	1.9	1.2	1.8	1.1	1.8	1.2	1.6	1.1
S.D.	0.18	0.23	0.15	0.18	0.17	0.16	0.13	0.14	0.11	0.18

Speech Sound Discrimination.—The concern of previous investigators has been with the plateau or ceiling reached near the top of the discrimination curve, more than with any other segment.[3,6-8] Table 4 gives the averages for the correct responses of both groups at each level tested above detectability threshold, and the figure illustrates the discrimination curves for both groups. It can be seen that the mean number of responses for the experimental group was higher than that of the control group at the lower sound pressure level. Moreover, the continued advantage of experimental over control group can be seen up to a level of 30 db. above detectability threshold.

TABLE 4.—*Mean Speech Sound Discrimination Scores by Sound Pressure Level Above Detectability Threshold*

Level (Db.)	Control		Experimental	
	Mean	S.D.	Mean	S.D.
2	1.8	0.13	2.8	0.69
4	2.7	0.63	4.3	0.87
6	3.7	0.89	4.6	0.86
8	4.5	1.3	5.6	0.13
10	5.6	1.1	6.9	1.1
12	6.8	1.3	7.0	1.0
14	6.0	1.0	7.0	1.1
16	6.2	0.84	7.9	0.89
18	7.3	1.2	8.3	0.86
20	7.1	1.1	8.4	1.2
22	7.6	1.6	8.4	0.80
24	7.9	1.2	8.5	1.1
26	8.9	1.3	8.8	0.74
28	9.1	0.63	9.1	0.70
30	9.2	0.95	9.0	0.63

In the analysis of the top of the discrimination curve, no significant differences were found in any of the main effects. The sound discrimination plateau found in previous publications[3,6,7,10] to be characteristic of persons exhibiting the recruitment phenomenon was found in this experiment, but at a higher level of correct discrimination than previously reported. Moreover, a virtually identical plateau was reached by the normal hearing subjects.

Conclusions

Within the limitations imposed by the sources of error, as well as the limitations imposed by the restricted number of frequencies and sensation levels tested, the following conclusions are offered:

1. Normal hearing persons are distinguishable from persons with impaired hearing of the type diagnosed as recruitment on the basis of the following test performance:

(*a*) Range of Comfortable Loudness: A more restricted RCL is characteristic of the auditory perception of persons exhibiting the recruitment phenomenon than persons possessing normal hearing.

(*b*) Difference Limen: A smaller difference limen is characteristic of the auditory perception of persons exhibiting the recruitment phenomenon than persons possessing normal hearing.

(*c*) Speech Sound Discrimination: A higher number of correct responses in a restricted range immediately above the threshold of detectability is characteristic of the auditory perception of persons exhibiting the recruitment phenomenon than persons possessing normal hearing.

2. The extent of the range of comfortable loudness and of the difference limen depends upon the frequency of the stimulus tone. In general, smaller DL's and RCL's are found above 2000 cps than below that frequency.

3. In general, the extent of the DL is inversely proportional to the sensation level of the stimulus tone, while the number of correct speech sound discriminations is directly proportional to the sensation level.

4. Smaller difference limens are found when listeners must discriminate the onset of warble from a steady-state tone than when the presentation is from the warble tone to the steady-state tone.

Purdue University (Dr. Hanley).

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Case Reports

Hypersensitization to Penicillin and Streptomycin Sulfate During Proetz Displacement

A. B. VICENCIO, M.D., Cebu City, Philippines

The literature is replete with reports of antibiotic reactions, especially on parenteral administration. In otolaryngology, just like any other specialty, we depend a great deal on the use of the wonder drugs.

Proetz displacement is a wonderful diagnostic and therapeutic procedure, so much so that I have given up entirely irrigations through the natural ostium and puncture of the inferior meatus. For the last eight years, Proetz displacement has been the office routine for sinus cases with the use of saline solution only (ephedrine omitted due to objectionable bitter taste), the last batch of the salt solution being mixed with about 0.1 gm. of penicillin and dihydrostreptomycin (Penstrep; Combiotic) with the aim of retaining the antibiotics in the sinuses. This procedure was employed without any adverse effects until the case reported below.

Report of Case

A 30-year-old Chinese woman complained of tenderness over the left maxillary area and moderate left-sided headache. She was pregnant four months. On examination, the left nasal vestibule was ringed by irritative excoriations of the skin, and the left nasal cavity was moderately congested. The right nasal cavity appeared normal.

Following office routine, two pledgets of cotton wound around two toothpicks, wet with tetracaine (Pontocaine), 2%, and epinephrine (Adrenalin), 1:1000, were inserted into the middle meatuses and left there for 10 minutes or so. Proetz displacement was done with plain saline solution and the remaining one-third of the solution in the syringe mixed with 0.1 gm. of penicillin-dihydrostreptomycin powder for the last suction.

The first two days were fine: The pus sucked from the left nasal cavity diminished considerably and the skin excoriations around the vestibule dried up nicely. On the third day, there was very little pus, but on arriving home she had two hours of itching, about which she did not tell me. The fourth day, Proetz displacement showed no more pus. Just as she was about to pay the secretary, she was rushed back to the treatment room, as she became red as a boiled lobster, itched all over, had a stuffy nose, but no signs of respiratory distress or collapse. She was immediately injected with 0.5 cc. of methapyrilene (Histadyl; Thenylpyramine); the itching subsided in about half an hour. Epinephrine was not injected, as she had no symptoms of syncope. As a precautionary measure, she was given per orem one tablet of amphetamine (Phenedrine).

What makes this case interesting are the sensitization occurred on the third day, the allergic manifestations were mostly cutaneous, and the absorption of a relatively small amount of penicillin and dihydrostreptomycin through the mucous membrane of the nose precipitated the reaction. Trivial as this report may be, perhaps it will teach us a lesson that the administration of antibiotics in Proetz displacement is after all not as harmless as we think.

Summary

Reported is a case of hypersensitization to antibiotics during Proetz displacement.

581 Jones Ave. (East Capitol Site).

Accepted for publication Aug. 20, 1956.

From the Eduarda Bautista Research for E. E. N. T.

Abstracts from Current Literature

Ear

Fenestration Operation in the Poor Candidates: Forty-Four Cases Selected from Six-Hundred Thirty-Seven Operations. J. Brown Farrior, Laryngoscope 66:566 (May) 1956.

Farrior discusses the results of fenestration operations done on candidates who by the usual criteria would not be considered suitable. These people are not expected to have serviceable hearing postoperatively. They have an associated or independent nerve degeneration, sometimes well below 40 db. at 2000 d.v. There must be, however, a suitable air-bone gap present for the operation to be undertaken. The results then are surprisingly good. From an almost complete deafness, a partial hearing is obtained, and even though this hearing is below the 30 db. level, it is beneficial and greatly appreciated.

Many times a hearing aid is also needed. With such, the hearing can usually be brought up to well within the serviceable range. That an aid may be necessary is, of course, explained to the patient before operation.

Hitschler, Philadelphia.

Differential Diagnosis of Hearing Problems of Adult Patients. Harriet L. Haskins, Laryngoscope 66:658 (June) 1956.

Certain persons present complex hearing problems not solved by routine audiometry. These persons' ability (or inability) to communicate differs obviously from that which the ordinary tests indicate. In such a situation more information is needed. A list of questions is suggested to help determine the difficulty.

Tests that are useful in addition to the threshold audiogram and the relationship between the air and bone conduction are the speech discrimination and the psychogalvanic skin resistance test. The latter gives a result free from behavioral complications. Cases are presented showing how the psychogalvanic skin resistance measurements combined with other means lead to a diagnosis probably unobtainable otherwise. Examples of such are the following: combinations of functional and organic lesions, difficulties with auditory perception and/or language association and related problems.

Hitschler, Philadelphia.

Larynx

Death During General Anesthesia for Bronchoscopy in a Child. Merel H. Harmel, New York J. Med. 56:1832 (June 1) 1956.

This is one of a series of reports prepared by the Anesthesia Study Committee of the New York Society of Anesthesiologists. The aim of this group is to study causes of medical emergencies in the operating room. It is emphasized that anesthetists should aim to know every detail of a patient's preoperative condition, and not depend on the work-up (or lack of it) by previous attending physicians or surgeons. This may seem like intrusion, but the anesthetist has a human life in his hands and often has a greater responsibility than the surgeon. The case report describes a frail 8-year-old white boy who was diagnosed as asthmatic because of wheezing and general respiratory embarrassment. A pediatrician diagnosed inspiratory rather than expiratory dyspnea. The general physical was fairly negative, including x-ray of the chest, which disclosed no foreign body! However, bronchoscopy was done to determine this fact through actual vision. The patient did badly on the table and in 35 minutes was pronounced dead. Autopsy disclosed an occluding tracheal papilloma several centimeters above the tracheal bifurcation.

Abstracter's Comment: A reading of the history would lead any bronchoscopist to suspect a foreign body. The intratracheal mass was just that. It must have been sessile in

that it moved about, giving partial obstruction at all times, but complete obstruction only when the patient was on the operating table. In any such case tracheotomy should always be done when the patient is *in extremis*. But here the obstruction was below any stoma which one could have made. However, removal by bronchoscopy through the stoma might have succeeded. Who can say?

I. W. Voorhees, New York.

Intubation of the Trachea Does Not Absolutely Insure a Patent Airway. Merel H. Harmel, New York J. Med. 56:2125 (July 1) 1956.

This is No. 12 in a series of clinical conferences on medical emergencies in the operating room during anesthesia. The report concerns a 47-year-old man who was being operated upon for a spinal injury. Blind faith in the efficacy of intubation without proper inspection of the apparatus is set down as the cause of death. Preoperative meperidine (Demerol) followed by thiopental anesthesia and intubation by a cuffed intratracheal tube was readily accomplished. However, it was soon noticed that the blood was dark and that severe cyanosis was present. Ether-oxygen was administered, but was of no avail. The chest was opened, cardiac massage was carried out for 38 minutes, but the left lung could not be inflated! Removal of the tube and inspection showed a bolus of air trapped in the distal portion of the cuff. Anoxia resulted; death came. It is advised in all such emergencies to pull the tube out promptly to ensure its patency. A kink is not uncommon, or a foreign substance may have swept in during tubal insertion, especially if carried through the nose. It is also possible to push the tube beyond the carina into the right bronchus, thus leading to atelectasis of the left lung. One should observe the movements of both sides of the chest and listen by stethoscope to determine obstruction. Mechanical failure is too often preceded by human failure. One must be astute and alert in all aspects of clinical practice, especialy in giving anesthesia (by whatever method).

I. W. Voorhees, New York.

Nose

Malignant Lymphomas of the Nose and Throat. R. R. M. Harman, J. Kodicek, and J. L. Pinniger, J. Laryng. & Otol. 70:377 (July) 1956.

This article is a detailed review and analysis of the total of 16 malignant lymphomas of the nose and throat which were histologically proved at St. Thomas's Hospital in London between 1934 and 1954. The authors review the nomenclature of sarcomas and establish in the mind of the reader the exact definitions that they have applied. This is followed by a rather detailed case history of each of the patients, in which diagnosis, treatment, subsequent course, and postmortem findings are reviewed.

The individual case histories are followed by an analysis and discussion of the group as a whole. Frequency, clinical features, pathology, histologic features, prognosis, and treatment are individually discussed. General features that were definitely noted included the fact that the tonsils were involved in more cases than any other area, and that reticulum-cell sarcoma was the commonest histologic type. The tumors held a poor prognosis and tended to generalized spread. An occasional patient would survive many years. The treatment preferred was radiotherapy, and it proved consistently effective in causing regression of the primary tumors, with less effect on subsequent treatment to recurrent areas.

LeJeune and Stevenson, New Orleans.

Submucous Resection and Nasal Plastic Operation: Septorhinoplasty. David Bernstein, New York J. Med. 56:1937 (June 15) 1956.

Bernstein is a surgeon at the Otolaryngology Division of University and Bellevue Hospitals, New York. He asserts that submucous resection is required in practically all rhinoplastic cases. Converse, Holmes, and Huffman have pointed out that it is usually the septum and not the nasal bone that is broken, especially in children, in nasal injuries. A one-stage procedure is to be preferred, and Bernstein suggests the word "septorhinoplasty" to describe it. The steps are elevation of the pyramid, transfixion, hump removal, shortening, submucous resection, lateral osteotomy, trimming of upper lateral cartilages, and molding of lower lateral cartilages. The essential is completely to mobilize the septum. This sequence has been used by Bernstein in his latest 33 cases with gratifying results from both functional and esthetic standpoints. Two figures and twenty references illustrate the points made.

ABSTRACTER'S COMMENT: This essay comes somewhat as a surprise to this reviewer, who has done the single-stage operation for years past and has seen it done by colleagues, at least in New York City. It seems better to do the septum first, then the external nose, because the submucous resection may be the more difficult, and it is well to do the hardest part of any operation, if possible, first. Of course, this is often impossible, and one must work from status quo. Retention of the correction, by whatever means, is imperative. Removal of cartilaginous and ossific centers in children may be hazardous to the final result.

I. W. VOORHEES, New York.

THE PRINCIPLE OF COOLING AS APPLIED TO THE COMPOSITE GRAFT IN THE NOSE. J. J. CONLEY and P. H. VONFRAENKEL, Plast. & Reconstruct. Surg. 17:444 (June) 1956.

Cooling decreases the degree of biological activity of all types of body tissues. The author caused cooling by the application of ice and ice compresses, applied constantly to the supportive postoperative nasal dressing, beginning immediately and continuing for two weeks. The skin temperature dropped from 97 F to as low as 78 F. The cases were postradiation conditions. In 12 cases, only 2 failed. The cooling is believed to have favored the take of the composite grafts.

SELTZER, Philadelphia.

Pharynx

ADVANTAGE OF ROUTINE ENDOTRACHEAL ANESTHESIA FOR TONSILLECTOMY IN CHILDREN. ALFRED GRANATELLI and VINCENT J. COLLINS, New York J. Med. 56:1761 (June 1) 1956.

These studies were made in the Department of Anesthesiology at St. Vincent's Hospital, New York. The report was read at a meeting of the State Society at Buffalo, May 13, 1955. Intubation anesthesia is seldom used because of two misconceptions: (1) that the technique is too hazardous and (2) that the insufflation procedure is innocuous. Taking of pulse, blood pressure, etc., has been neglected; hence, their influence on a patient's physiology has been unknown. Hurried surgery has been lifesaving—a sort of negative blessing! Two tables are set up to show the comparative pulse rates and systolic pressure rises during use of the two opposed methods. Also two anesthesia case records are given for like reason. To summarize, all patients maintained under the ether hook insufflation technique aspirated blood into the trachea. Only one of the intubated patients had blood in the trachea! Blowing anesthetics through the hook causes obstruction by blood packs, surgical manipulation, tongue, and laryngospasm. Therefore, we have hypoxia and carbon dioxide accumulation with cyanosis and increased heart rate beat. The insufflation method is not innocuous, since there are perverted physiology and stress on the cardiovascular system. Hypoxia results promptly from any respiratory obstruction which prevents free use of oxygen in the air. This distress is not relieved by administering 100% oxygen; only removal of the obstruction can do that. Endotracheal anesthesia avoids hypoxia and prevents aspiration of mucus and blood. It is the ideal procedure.

I. W. VOORHEES, New York.

RESPIRATORY OBSTRUCTION CAUSED BY ACUTE TONSILLITIS AND ACUTE ADENOIDITIS. SIDNEY SPECTOR and ARISTON G. BAUTISTA, New York J. Med. 56:2118 (July 1) 1956.

The authors report two cases where acute infection of the upper airways involved tonsils and adenoids, and caused serious dyspnea. Immediate tracheotomy relieved the status, the patients recovered, and the A and T operation was left for a time when the infection had disappeared. The observation is made that such obstruction due to infection is unusual. The temptation is to go ahead with removal of tonsils and adenoids, but the objections are that a child fairly exhausted by dyspnea may do poorly under general anesthesia; new pathways for extension of infection may be opened, resulting in general septicemia; secondary hemorrhage of severe degree is likely.

ABSTRACTER'S COMMENT: We have here an excellent reason for doing prompt tracheotomy instead of the common A and T procedure. It is a good rule in all cases of dangerously obstructed breathing to do a tracheotomy, then deal with the cause at a later time. This may well be true of acute glottic edema from whatever cause, for example, a foreign body between the cords, or diphtheritic membrane. Tracheotomy is a relatively simple procedure. If the patient is "blue" no anesthesia is necessary. As soon as air enters the stoma, relief

is immediate, and a cause for rejoicing by all concerned. This viewpoint needs to be more thoroughly emphasized than it has been in the past.

I. W. Voorhees, New York.

Miscellaneous

Plastic Surgery of the Eyelids. K. Pickrell, N. Georgiade, C. Maguire, and H. Crawford, Am. J. Surg. 92:61 (July) 1956.

The authors have prepared their paper particularly for the benefit of the general surgeon. Attention is called to the fact that wounds of the lids may range from small lacerations to complete destruction. The commonest causes of these injuries are automobile accidents. An important point to observe in preparing to operate is the direction of the laceration—whether horizontal or vertical—the latter with injury to the tarsal plate or to the eyelashes, and disfiguring contractions. Particularly recommended is repeated flushing of the wound to remove all foreign material and accumulated clots. The exact method of operating must necessarily depend upon the amount of tissue lost, but careful approximation of the wound edges and placing of sutures is of first importance to avoid distortion. Penicillin ophthalmic ointment is introduced into the conjunctival sac after the wound is closed, to prevent irritation to the cornea. A dressing of petrolatum gauze is applied over the suture line and the eyelids, covered with a layer of small, dry sponges held in place by cellophane or adhesive tape. Drainage is not necessary.

Seltzer, Philadelphia.

Masking of Impaired Ears by Noise. Charles Lightfoot, Raymond Carhart, and John H. Gaeth, J. Speech & Hearing Disorders 21:56 (March) 1956.

Thirty-one normal hearing university students were compared with seventeen adults with conductive losses and forty-two adults with perceptive losses for pure-tone and spondee thresholds in quiet and in two levels of white noise to test the hypothesis that such noise would produce the same amount of masking in an ear which is impaired as it would produce in a normal ear. The number of abnormal M-Z relationships which were found in the data obtained for hypacusic subjects tended to invalidate the hypothesis. The results suggest that the concept of the "critical band," as formulated by Fletcher and others, may have limited applicability, especially if the impairment is of the perceptive type.

Palmer, Wichita, Kan.

Factorial Analysis of Speech Perception. Clair N. Hanley, J. Speech & Hearing Disorders 21:76 (March) 1956.

One hundred fifty students at the State University of Iowa were given thirty-two tests in controlled conditions and the scores analyzed to determine consistencies which would indicate the various factors operating in the area of speech perception. Eight factors—(1) verbal facility, (2) threshold of detectability for tones, (3) Seashore battery, (4) voice memory, (5) and (6) resistance factors, (7) unpleasantness, and (8) synthesis—were found and tentatively identified by factorial analysis.

Palmer, Wichita, Kan.

Disease of the Facial Nerve. Francis H. McGovern and G. Slaughter Fitz-Hugh, Laryngoscope 66:187 (March) 1956.

This is a comprehensive report on diseases of the facial nerve. It includes a discussion of the anatomic features and facial palsies (their etiology, diagnosis, medical and surgical treatment, and sequelae). Also included are tumors of the facial nerve, Melkersson's syndrome, tic douloureux of the nervus intermedius, herpes zoster, geniculate neuralgia, and the surgical aspects of the parotid portion. In paralysis, it is urged that active treatment be employed rather than just waiting and hoping. The vasodilator drugs have produced good results in Bell's palsy. The indications for surgical intervention, still a debatable question, are discussed in detail. Methods of repair are also discussed. One hundred nineteen references are listed in the bibliography.

Hitschler, Philadelphia.

APC Viruses in Respiratory Diseases—Clinical Aspects. Robert H. Parrott, Laryngoscope 66:628 (June) 1956.

Many viruses have been found to be present in adenoidal, pharyngeal, and conjunctival tissues. They are therefore called the APC viruses. There are at least 10 or 11 immuno-

logically distinct types. The whole group shares a specific soluble antigen which gives a reaction in a complement fixation test. Serological tests show that over 50% of infants and a much greater proportion of older people have been infected with at least one type of the APC virus.

The major symptom of APC infection is fever (90%); sore throat, red eyes, headache, and malaise follow. Lymphadenopathy is common.

Children are most susceptible, but no age or sex is immune. The spread is by direct contact, probably by respiratory secretions. There is no specific treatment for this disease.

Drugs and antibiotics do not seem to affect the outcome, although the latter are indicated when complications arise. It is hoped that in the not too distant future an immunizing agent will be developed to prevent this disease.

HITSCHLER, Philadelphia.

REVIEW OF THE CORTICOSTEROIDS—THEIR APPLICATION TO OTOLARYNGOLOGY. AUBREY G. RAWLINS, Laryngoscope 66:674 (June) 1956.

Rawlins reviews the physiology of the production of hydrocortisone and ACTH, and the anatomy and physiology of the connective tissue which is affected by these steroids. The capillary bed is a part of the connective tissue. No body cell is nourished directly by blood vessels. The nourishment must first pass through the ground substance of the connective tissue. The most important cells of the connective tissue are the fibroblasts and the mast cells. The latter, under stress, produce histamine and a polysaccharide which is a hyaluronidase (an enzyme) inhibitor. In inflammation this enzyme is increased some 40 times. The constitution of the connective tissue is always in a state of flux. Hyaluronidase has much to do with these changes. A firm ground substance acts against the invasion of bacteria and virus, and an edematous one allows easy access.

The action of the corticosteroids in regard to inflammation, infection, and capillary and connective-tissue permeability is then reviewed in detail. Large doses seem to enhance both bacterial and viral infections, while small doses combat them. In viral upper respiratory infections, these small doses, with the addition of ascorbic acid and a bioflavonoid, are sometimes very beneficial. The corticosteroids are used in the treatment of many otolaryngological conditions, including allergies, Bell's palsy, edema, and polyps, and are being tried in Ménière's syndrome. Other conditions in which they are useful are mentioned.

The article is very well worth reading in full.

HITSCHLER, Philadelphia.

HEMOPTYSIS—A DIAGNOSTIC PROBLEM. JOHN F. DALY, New York J. Med. 56:2075 (July 1) 1956.

Daly is Chief of Otolaryngology at the Bellevue and University Hospitals and in the Post-Graduate Medical School. He presented this important paper before the New York State Medical Society in a general session in May, 1956. Tuberculosis is no longer the number-one killer; it has been replaced by heart disease (first) and cancer (second). Newer techniques, such as bronchography, and cytologic studies have made early diagnosis highly possible. Grouping the causes under broad categories, one must consider the following: (1) cardiovascular diseases (stenosis, increased B. P., infarcts, aneurysm, telangiectasis); (2) bronchopulmonary conditions (infections caused by parasites, fungi, and Rickettsiae, tuberculosis, pyogenic lung abscesses, pneumonitis, tracheobronchitis, neoplasms, bronchiectasis, fibrosis, and trauma of various kinds); (3) general diseases (dyscrasias, such as leukemia and purpura, also uremia and sarcoidosis); (4) undetermined diseases. X-ray is highly important, of course, but not all "shadows" can be properly interpreted. We may find tuberculosis and cancer lying together in symbiosis. Smears should be made not only to detect acid-fast organisms, but we need to use the Papanicolaou stains to detect tumor cells also. Fungi may elude us. Gastric washings need centrifugation and stain studies.

Bronchoscopy with scrapings and washings has increased positive findings.

Malignancy must be uppermost in thought in all differentials. Cough, hemoptysis, and an unusual x-ray picture call for presumptive evidence of cancer. Then, all "tools of evidence" must be brought into action. Thoracotomy may be justified if the chest surgeon thinks it wise. Truly, "It is better to resect an innocent lesion than to wait . . . until no resection is possible."

Idiopathic hemoptysis is still a *bête noire*. We must always assume that everything has a cause. It is up to us to find it! The male between 30 and 50 may give us the most trouble. One hemorrhage without recurrence fouls up our thinking, and recurrence is always suspect for serious pathology. Such patients must be reexamined at intervals to make sure we are not deceived by apparently harmless "streaks of blood." Of course we will study the upper airways and foodways to make sure that these are not sources of origin.

ABSTRACTER'S COMMENT: This is a studied, comprehensive, and wise *Arbeit*. If it is followed in all details, it will lead us to a positive diagnosis, perhaps "delayed in transit," but as determinative as is humanly possible. We are now at the stage where "oversight" is not only inexcusable but fairly borders on criminal negligence.

I. W. VOORHEES, New York.

News and Comment

GENERAL NEWS

Specialists Certified by the American Board of Otolaryngology.—The following physicians were certified as specialists by the American Board of Otolaryngology at the recent examination held Oct. 8-12, 1956:

Acharyulu, M. V. R., New York 25.
Adams, Leon A., Princeton, N. J.
Arsenault, Armand, Montreal, Canada.
Baade, Ernest A., Lewistown, Pa.
Basek, Milos, New York 32.
Billman, Howard G., Marysville, Calif.
Blackburn, Edward A., Jr., Houston, Texas.
Brophy, John W., Reno, Nev.
Bruce, Robert G., Greenville, Texas.
Bryce, Michael R., New York 21.
Chodosh, Paul L., Roselle, N. J.
Christensen, Earl W., Lexington, Ky.
Cunningham, John D., Philadelphia 31.
Fogle, Richard J., Racine, Wis.
Gozum, Ekrem, Minneapolis.
Harrison, Lloyd B., Jr., Panama City, Fla.
Hobart, Seth G., Jr., Durham, N. C.
House, William F., Los Angeles 17.
Howard, John C., Athens, Ga.
Hyman, Barnett M., Beaumont, Texas.
Jacks, Quentin D., Vancouver 2, B. C., Canada.
Kapur, Yash Pal, Boston 18.
King, Robert L., Jr., Great Lakes, Ill.
Kohn, Ralph B., Castro Valley, Calif.
Kolson, Harry, Syosset, L. I., N. Y.
Lu, Cheng-en, Minneapolis 14.
McLean, Walter Copley, Charlottesville, Va.
Mansueto, Mario D., East Chicago, Ind.
Marchand, Leopold, Montreal, Canada.
Marshall, Bruce R., Rockford, Ill.
Merklin, Lewis, Philadelphia 31.
Nelson, Bentley A., Camp Lejeune, N. C.
Noguera, Julio T., Roosevelt, Puerto Rico.
Pollak, Kurt, Minneapolis 14.
Raines, Donald S., Rochester 7, N. Y.
Roach, George S., Jr., Atlanta.
Saunders, Leslie, Amsterdam, N. Y.
Schofman, Manuel A., Miami Shores, Fla.
Seltsam, Jack H., Los Angeles 24.
Shaffer, John F., Havertown, Pa.
Sheehy, James L., New York.
Shimo-Takahara, George, Montreal, Canada.
Smith, Gerald L., Cheyenne, Wyo.
Strong, M. Stuart, Boston.
Torok, Nicholas, Chicago 2.
Weyand, George M., Bakersfield, Calif.

ANNOUNCEMENTS

Session on Allergy in the Section on Miscellaneous Topics.—Any member who wishes to present a paper at the Allergy Session of the American Medical Association Convention to be held in New York City in June, 1957, should write for "Suggestions for Authors of Section Papers" and Standing Rules of Sections. Abstracts of papers, 250 words or less, will be accepted for possible inclusion in the program until Jan. 15, 1957. Time and place will be announced at a later date. For information write the Secretary.

Co-Chairmen: Carl E. Arbesman, M.D.
Buffalo
President: American Academy of Allergy
Ethan Allan Brown, M.D.
Boston
President: American College of Allergists
Secretary: Clarence Bernstein, M.D.
740 Magnolia Ave.
Orlando, Fla.

Seventh International Cancer Congress.—The Seventh International Cancer Congress, sponsored by the International Union Against Cancer, will be held in London, England, July 6-12, 1958, under the Presidency of Sir Stanford Cade. Congress headquarters will be The Royal Festival Hall.

There will be two main sessions of the Congress:

A. Experimental
B. Clinical and Cancer Control

Special emphasis will be placed on Hormones and Cancer, Chemotherapy, Carcinogenesis and Cancer of the Lung.

Proffered papers will only be considered if submitted with an accompanying abstract (not over 200 words) before October, 1957, and if dealing with new and unpublished work.

The registration fee for the Congress will be £ 10 (or $30.00), and the latest date for registration without late fee will be Jan. 1, 1958.

Registration forms and a preliminary program will be available early in 1957 on application to

The Secretary General
Seventh International Cancer Congress
45 Lincoln's Inn Fields
London, W. C. 2, England

J. H. Maisin, President
Union Internationale Contre Le Cancer
Voer des Capucins, 61
Louvain, Belgium

Harold Dorn, Secretary General
Union Internationale Contre Le Cancer
National Institute of Health
Bethesda 14, Maryland, U. S. A.

International Conference on Audiology.—There will be an International Conference on Audiology in St. Louis beginning the afternoon of May 13 and continuing through May 16, 1957. The Conference will be included as part of Tours 2 and 3 (to the Middle West and Far West) that are being planned in connection with the Sixth International Congress of Otolaryngology, to be held in Washington in May, 1957.

The following themes will be discussed: (*a*) The Assessment of Auditory Function, (*b*) The Physiology of Audition, and (*c*) The Relation of Hearing Loss to Noise Exposure.

The program has not been finally crystallized, but it is likely that the majority of contributions will be invited. One afternoon has been set aside for a small number of contributed papers relevant to the themes of the Conference. Persons desiring to contribute papers should submit an abstract to the Program Chairman no later than March 1, 1957. The aim of the Conference is to have scientists and clinical workers share views and findings on the above subjects. Visits to local audiological and otological facilities will be included.

The Chase Hotel is the official hotel of the Conference, but housing at varying prices will be available. Although not yet determined, there will be a nominal registration fee.

The Conference is being partly supported by a grant from the National Science Foundation to the Central Institute for the Deaf.

The Program Chairman is Dr. Ira J. Hirsh, Research Associate, Central Institute for the Deaf, 818 S. Kingshighway, St. Louis 10, Mo.

The National Organizing Committee is as follows:

Raymond Carhart, Ph.D., Professor of Audiology, Northwestern University
Hallowell Davis, M.D., Director of Research, Central Institute for the Deaf; Research Professor of Otolaryngology and Professor of Physiology, Washington University School of Medicine
Harvey Fletcher, Ph.D., Director of Research, Brigham Young University; formerly Physical Research Director, Bell Telephone Laboratories
William G. Hardy, Ph.D., Director, Speech and Hearing Center; Associate Professor of Otolaryngology and Environmental Medicine, Johns Hopkins Hospital
John Lindsay, M.D., Professor of Otolaryngology, University of Chicago
Philip E. Meltzer, M.D., Professor of Otolaryngology, Tufts University Medical School
S. S. Stevens, Ph.D., Professor of Psychology, Harvard University
S. R. Silverman, Ph.D., Director of Central Institute for the Deaf; Professor of Audiology, Washington University; Chairman

Additional plans will be communicated as they are formulated. For information write to: S. R. Silverman, Chairman, International Conference on Audiology, Central Institute for the Deaf, 818 S. Kingshighway, St. Louis 10, Mo.

The British Columbia Oto-Ophthalmological Conference.—The British Columbia Oto-Ophthalmological Conference will be held in Vancouver, B. C., Canada, on May 23 and 24, 1957. Guest speakers will be Dr. Alston Callahan, of Birmingham, Ala., in Ophthalmology, and Sir Victor Negus, of London, England, in Otolaryngology. Members of neighboring eye, ear, nose, and throat societies are cordially invited to attend.

The Sixth International Congress of Otolaryngology.—The date for the acceptance of papers and films for the program of the Sixth International Congress of Otolaryngology has passed and the scientific program has been completed. There are 238 papers that will be presented simultaneously in four sections during each General Session. These represent contributions from otolaryngologists in 35 countries and deal with a remarkably wide variety of subjects in the specialty.

Applications for the presentation of films have been sufficient to provide 18 hours of motion pictures, which will run simultaneously with the presentation of scientific papers.

Forms for requesting hotel reservations in Washington have been distributed to all who have registered as Members of the Congress. Those wishing to register should communicate with the General Secretary, 700 N. Michigan Ave., Chicago 11, Illinois, U. S. A. Applications for hotel accommodations will be sent as soon as registration is completed.

Directory of Otolaryngological Societies *

FOREIGN AND INTERNATIONAL

Canadian Otolaryngological Society

(Société Canadienne d'Otolaryngologie)

President: Dr. G. M. T. Hazen, 208 Canada Building, Saskatoon, Sask.
Secretary: Dr. G. A. Henry, 328 Medical Arts Building, Toronto.
Place: Banff Springs Hotel. Time: June 17-19, 1957.

International Bronchoesophagological Society

President: Dr. Theodor Hünermann, Düsseldorf.
Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.
Meeting: Sixth International Congress of Bronchoesophagology.
Place: Philadelphia. Time: May 12-13, 1957.

International Congress of Audiology

Place: Leyden, Netherlands.
General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Netherlands.

International Course in Paedo-Audiology

Place: Groningen, Netherlands.
General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Netherlands.

Pan-American Association of Oto-Rhino-Laryngology and Broncho-Esophagology

President: Dr. José Gros, Havana, Cuba.
Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.
Meeting: Sixth Pan-American Congress of Oto-Rhino-Laryngology and Broncho-Esophagology.
Place: Brazil. Time: 1958.

Sixth International Congress of Otolaryngology

President: Dr. Arthur W. Proetz, 3720 Washington Blvd., St. Louis.
General Secretary: Dr. Paul H. Holinger, 700 N. Michigan Ave., Chicago 11.
Place: Hotel Statler, Washington, D. C. Time: May 5-10, 1957.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. John R. Lindsay, Chicago.
Secretary: Dr. Hugh A. Kuhn, 112 Rimbach St., Hammond, Ind.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Erling W. Hansen, 30 S. Ninth St., Minneapolis.
Executive Secretary-Treasurer: Dr. William L. Benedict, 100-1st Ave. Bldg., Rochester, Minn.

American Board of Otolaryngology

President: Dr. Frederick T. Hill, Professional Building, Waterville, Maine.
Secretary-Treasurer: Dr. Dean M. Lierle, University Hospitals, Iowa City.

American Broncho-Esophagological Association

President: Dr. Clarence W. Engler, 2323 Prospect Ave., Cleveland.
Secretary: Dr. F. Johnson Putney, 1719 Rittenhouse Sq., Philadelphia 3.
Place: Mark Hopkins Hotel, San Francisco. Time: May 21-23, 1958 (afternoons only).

American Laryngological Association

President: Dr. LeRoy A. Schall, 243 Charles St., Boston 14.
Secretary: Dr. Harry P. Schenck, 326 S. 19th St., Philadelphia 3.
Place: Statler Hotel, Washington, D. C. Time: May 3, 1957.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. Percy E. Ireland, 100 College St., Toronto, Canada.
Secretary: Dr. C. Stewart Nash, 700 Medical Arts Bldg., Rochester 7, N. Y.
Place: Mark Hopkins Hotel, San Francisco. Time: May 21-23, 1958.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

SECTIONS:

Eastern.—Chairman: Dr. Joseph Sullivan, Toronto, Canada.
Southern.—Chairman: Dr. Mercer G. Lynch, New Orleans.
Middle.—Chairman: Dr. Paul M. Moore, Cleveland.
Western.—Chairman: Dr. Sigurd v. Christierson, San Francisco.

AMERICAN OTOLOGICAL SOCIETY, INC.

President: Dr. John R. Lindsay, 950 E. 59th St., Chicago 37.
Secretary-Treasurer: Dr. Dean M. Lierle, State University of Iowa, Iowa City.
Place: Statler Hotel, Washington, D. C. Time: May 4, 1957.

AMERICAN OTORHINOLOGIC SOCIETY FOR THE ADVANCEMENT OF PLASTIC AND RECONSTRUCTIVE SURGERY, INC.

President: Dr. Joseph Gilbert.
Secretary: Dr. Louis Joel Feit, 66 Park Ave., New York 16.

AMERICAN SOCIETY OF OPHTHALMOLOGIC AND OTOLARYNGOLOGIC ALLERGY

President: Dr. Dean McAllister Lierle, University Hospital, Iowa City.
Secretary-Treasurer: Dr. Michael H. Barone, 468 Delaware Ave., Buffalo 2.
Place: Palmer House, Chicago.

SOCIETY OF MILITARY OTOLARYNGOLOGISTS

President: Col. Wendell A. Weller.
Secretary-Treasurer: Major Stanley H. Bear, M. C., 3810th USAF Hospital, Maxwell AFB, Ala.

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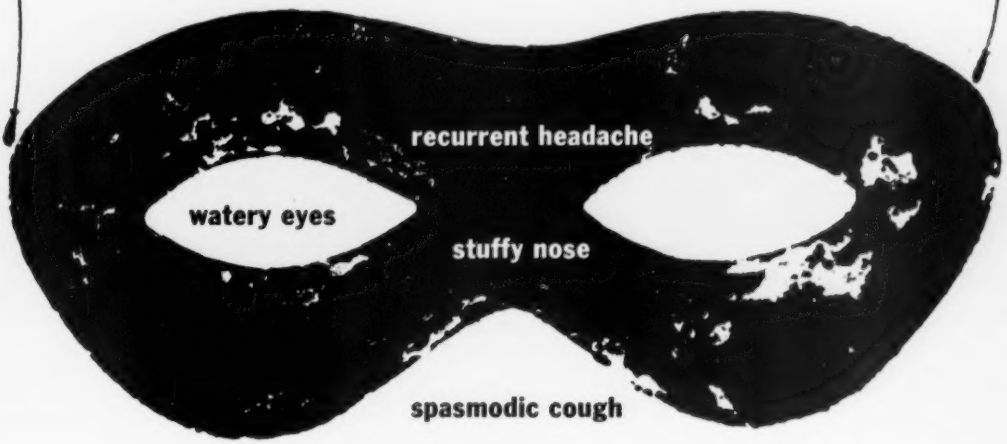

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Dr. A. C. Furstenberg, Dr. J. H. Maxwell, and Dr. J. E. Magielski.

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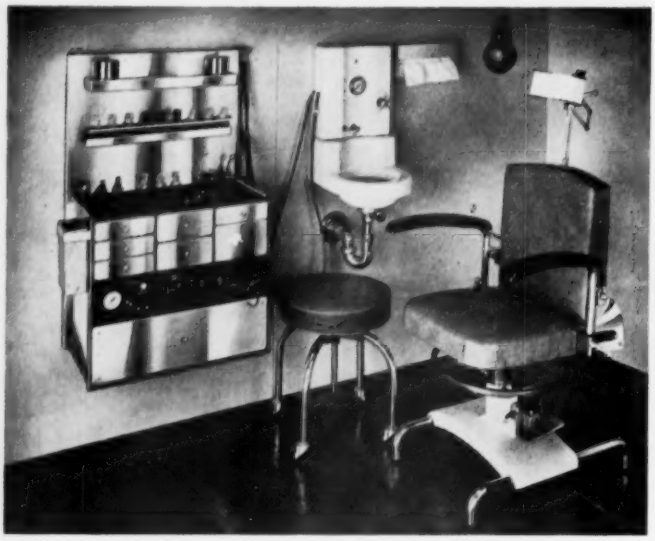

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Ref. Archives of Otolaryngology, February 1957

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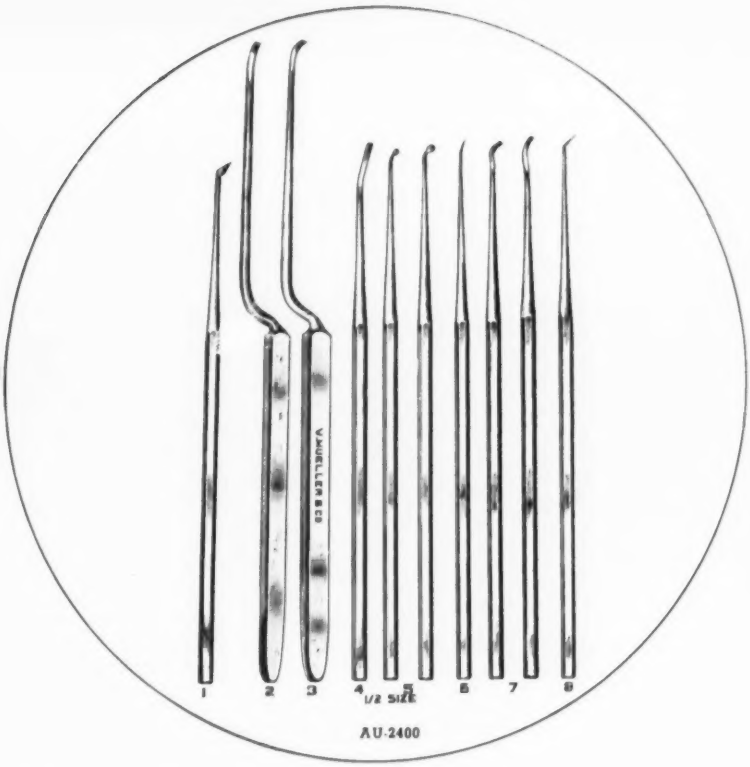

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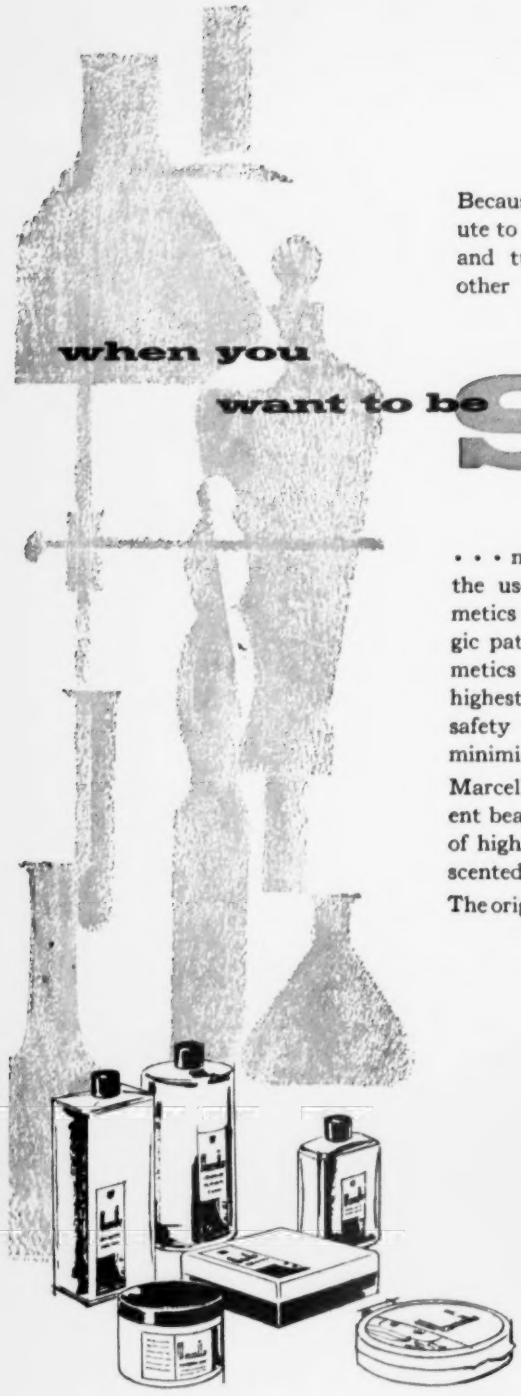

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